Wind Energy

Programmes Directory

TATA ENERGY RESEARCH INSTITUTE
DOCUMENTATION CENTRE

Bombay House, 24 Homi Mody Street, Bombay 400 023

Wind Energy Programmes Directory
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Compilation

Miss T. Rastogi
Mr. N. K. Gopalakrishnan

Secretarial Work

Miss R. H. Marker

For Further Information

The Documentation Officer,
Tata Energy Research Institute,
Bombay House,
24, Homi Mody Street,
Bombay 400 023,
India.

INTRODUCTION

Wind is a free, clean, inexhaustible energy source. Sufficient energy is continually being transferred from the sun to the winds of the earth to maintain an estimated total power capacity of over 10^{11} gigawatts (GW) in these winds. It is theoretically possible to recover about 60% of the energy in the wind (extracting all the energy would mean bringing all the wind to a dead stop, an interesting possibility). However, substracting the inevitable losses due to turbines/propellers, it is possible to recover only 35% of the total wind energy available at a particular site.

The use of wind as a source of energy is an old approach dating back some 2000 years to the Persian windmills. The traditional applications of wind have been to pump water for domestic uses such as livestock and irrigating crops to perform agricultural tasks such as grinding corn, crushing sugar cane threshing and wood cutting, for speciality applications such as moving saline water in salt works. By the turn of the last century, windmills were widely used for generating electricity. It is estimated that there were more than 0.6 million windmills operating in the world by the end of the last decade. In recent years, there have been attempts by organizations in both industrialized and developing countries to meld wind energy and more advanced technologies into usable forms. Feasibility studies have been initiated in a number of countries to assess the technical and economical problems of wind energy for a number of different applications.

The main effort in the developing countries is to design and fabricate simple, low cost windmill using locally available material and skill, mainly for agricultural applications.

Large government funded R&D programmes are in progress in the U.S.A. ($60 million in fiscal year 1978-79), Sweden ($20 million in triennum starting with fiscal year 1978-79), Canada, Denmark, West Germany, Holland and the U.K. (the latter five countries are each funded at over $1 million). These programmes include the construction of large (megawatt rated) and/or medium (hundred kilowatt rated) prototype wind generators; studies of structural dynamics; wind energy prospecting; data analysis and resource assessment; development of electrical and mechanical systems; computer studies of the integration of wind generators into electricity grids and economic studies. Current active programmes,

nationally sponsored are in Denmark, Sweden, West Germany, Netherlands, England, New Zealand, Canada and U.S.A.

Presented here in this directory are the activities of associations, organizations, institutions, universities, colleges, etc., involved in the field of wind energy in several countries.

Tata Energy Research Institute is grateful to all those who have contributed to this publication. The Institute proposes to report even more comprehensively on wind energy developments and usage worldwide. It seeks cooperation of all the organisations and individuals active in the field in reporting activities that should be included in the Directory to make it comprehensive and up-to-date. Any organisation inadvertently omitted here will find place in subsequent edition of the Directory.

EXPLANATORY NOTES

- The Directory is based on questionnaire survey supplimented by research in existing directories and conference proceedings.

- Main text is arranged in alphabetical order by country. Manufacturers' section is also in alphabetical order.

- Organizational profile consists of information such as name and address, contact person, activities, publications, personnel. Manufacturers' profile in addition includes information on products manufactured, and product specifications.

- Asterisks (*) prefixed to the entry indicates that the information is extracted from published literature and directories.

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INTERNATIONAL ORGANIZATIONS

1. * Economic Commission for Africa,
   P.O. Box 3001,
   Addis Ababa,
   Ethiopia.

   Telephone : 447200   Cable : ECA ADDISABABA
   Telex : 21029

The Commission is assisting in the establishment of the African Solar Energy Society and an Africa Solar Energy Centre. An intergovernmental meeting on new and renewable sources of energy in Africa was organized in January 1981 in Addis Ababa, Ethiopia.

2. * Economic Commission for Asia and the Pacific (ESCAP),
   United Nations Building,
   Rajadamnern Avenue,
   Bangkok 2,
   Thailand.

   Telephone : 28291 61   Cable : ESCAP BANGKOK
   Telex : 788 2392

Since 1974, one of the activities of ESCAP has been to investigate, develop and manage non-conventional energy resources. In 1976, ESCAP considered a report prepared by experts on the use of solar and wind energy in the ESCAP region for the purpose of regional coordination.

A field mission has been undertaken by ESCAP in 14 developing countries of the region.

ESCAP has plans to convene a seminar on planning management and economics of energy for rural areas during the second quarter of 1981. Directories of institutions and experts in the ESCAP region involved in the research and development of solar energy, wind energy, mini-hydropower and biogas are being prepared.

3. * Economic Commission for Europe,
Palais des Nations,
CH-1211 Geneva 10,
Switzerland.

Telephone : 34 60 11 Cable : UNATIONS GENEVA
Telex : 289696

ECE organised a Seminar on Technologies related to New Energy Sources at the Julich Nuclear Research Centre in the Federal Republic of Germany from December 8-12, 1980, covering solar, wind and geothermal energy as well as problems associated with the integration of new energy sources into existing power systems.

4. * The Department of Technical Cooperation for Development (DTCD),
The U.N. Centre for Natural Resources, Energy and Transport (CNRET),
New York, N.Y. 10017,
U.S.A.

Telephone : 7548575 Cable : 'UNATIONS NEWYORK'
Telex : 232422

In the Department of Technical Cooperation for Development, the CNRET is responsible in the field of natural resources, energy or transport and notably in the field of Solar and Wind Energy.

The Department prepared programmes on Solar and Wind Energy in the Cape Verde Islands (1976) in El Salvador (1977) and in the Sahelian region.

The Centre is also responsible for monitoring a project to set up Rural Energy Centres in Africa and Asia, to serve as demonstration units. The main concept of the Rural Energy Centres (REC) is the "energy mix" whereby solar energy, wind and biogas will complement each other for supplying energy for cooking, lighting, water pumping and running agro-based village industries. Sites have been selected in Senegal (at Ndia Gorey), Sri Lanka (at Pattiyapola) and in Mexico.

5. * The General Assembly and The United Nations
Conference on New and Renewable Sources of Energy,
1, United National Plaza,
New York, N.Y. 10017,
U.S.A.

The General Assembly at its last session in December 1978 approved the convening of a UN Conference on New and Renewable Sources of Energy to be held in 1981. The Conference will be held in Kenya from August 10-21, 1981. The objective of this Conference will be to promote the development and utilization of wind energy among other renewable energy sources.

6. * United Nations Children's Fund (UNICEF),
United Nations Plaza,
New York, N.Y. 10017,
U.S.A.

Telephone : 754-1234 Cable : UNICEF NEWYORK
Telex : 127895 (Western Union)

A UNICEF "Village Technology Unit" has been established in Kenya, jointly with the government's village Polytechnic Programme. Energy related demonstration and experimental equipment include wind powered water pumps. Windmills are being used by rural communities in N.E. Kenya with the help of UNICEF.

During 1976, UNICEF sponsored a regional seminar in Kenya, which was attended by 10 countries to explore the use of appropriate technologies in the rural areas of the world. In 1977, the Executive Board of UNICEF approved assistance to six African countries to establish village-level technology measures and training staff.

The organization sponsors visits of many people from different parts of developing countries to the projects.

7. * United Nations Development Programme (UNDP),
1, United Nations Plaza,
New York, N.Y. 10017,
U.S.A.

Telephone : 754-1234 Cable : 'UNDEVPRO NEWYORK'
Telex : 125980

The UNDP funds feasibility studies and technical cooperation projects at the request of Governments. It sponsors several projects concerning solar energy (which includes wind energy) applications, which are carried out by CNRET or by specialized agencies and bodies inside or outside the United Nations System.

Wind energy projects sponsored by UNDP are :

1) In Jamaica, on the possible use of alternative sources of energy including wind and waves.

2) In Kenya, on the feasibility of manufacturing wind powered water pumping equipment in Mbita Division, South Nyanza with UNIDO.

UNDP is also sponsoring regional projects

- for cooperation among Mediterranean countries on solar and wind energy;
- in Central and S. America on the potential of conventional and non-conventional energy development.

8. * United Nations Educational Scientific and Cultural Organization (UNESCO),
7, place de Fontenoy,
F-75700 Paris,
France.

Telephone : 577 1610 Cable : 'UNESCO PARIS'
Telex : 204461 PARIS

UNESCO has carried out a survey and analysis of programmes, facilities and needs in the field of education and training related to new and renewable sources of energy. As a step towards a more structured system for collecting and dissemination information

on new and renewable sources of energy (including wind energy), UNESCO has recently completed a study for an international information system in this area.

UNESCO continues a programme of work in the field of non-conventional sources of energy which comprises the following activities : -

1) Promotion of research in the scientific and technological field by sponsoring and co-sponsoring conferences and expert missions, publications and similar other activities.

2) Assistance in the creation or development of regional or sub-regional centres for research and training in solar/wind energy.

9. * United Nations Environment Programme (UNEP),
P.O. Box 30552,
Nairobi,
Kenya.

Telephone : 333930   Cable : 'UNITERRA NAIROBI'
Telex : 22068

UNEP has been assisting developing countries in dealing with their environmental problems. UNEP prepared a proposal for a study on the impact on the environment of the various sources of energy, including solar and wind energy, submitted in April 1979.

UNEP is also engaged in a project to set up Rural Energy Centres in Africa and Asia to serve as demonstration units with the object of encouraging developing countries to use alternative sources of energy. The main concept of the Rural Energy Centres as planned by UNEP is the "energy mix" whereby solar energy, wind energy and biogas will complement each other in supplying energy for the village.

10. * The United Nations Industrial Development Organization (UNIDO),
Vienna International Centre,
Wagramer Strasse 5,
P.O. Box 300,
A-1400 Vienna,
Austria.

Telephone : 26310 Cable : 'UNIDO VIENNA'
Telex : 135612

UNIDO provides technical assistance to developing countries on their request, for projects related in manufacturing of solar equipments. The components of this technical assistance may be in terms of experts, equipments or fellowships.

In Kenya, UNIDO sponsored a programme for the design of windmill-pumping equipment.

11. * United Nations University,
15-1 Shibuya 2 chome,
Shibuya-ku,
Tokyo 150,
Japan.

Telephone : 499-2811 Cable : 'UNATUNIV TOKYO'
Telex : J25442

The UN University, founded in 1973, has its headquarters in Tokyo and a network of research and advanced training operations in some 60 countries. It has undertaken pilot projects on solar, biogas and wind energy in rural communities in the developing countries.

UNU publishes a monthly periodical "ASSET, Abstracts of Selected Solar Energy Technology" which has a section on Wind Energy

12. * Organization for European Economic
Cooperation (OEEC),
Chateau de la Muette,
2, rue Andre Pascal,
75775 Paris, Cedex 16,
France.

OEEC group was established early in 1950 to encourage cooperative research and development in wind power. The group has held several meetings in Paris and in London which have been attended by representatives of a number of European countries that have wind power potentialities.

The most important outcome of the group's establishm has been the free exchange of information o.. the national activities in the subject and of ideas for future developments.

13. * The World Meteorological Organization (WMO),
Case Postale 5,
CH-1211, Geneva 20,
Switzerland.

The World Meteorological Organization has establish in 1976 a Plan of Action in the field of energy problems. The programme is mainly directed to the implementation of a wide range of research and development activities in the application of meteorolog including the use of wind and solar radiation. Under this programm a system has been established to exchange meteorological informati between the interested member countries.

To promote the utilization of non-conventional source of energy, specifically solar radiation and wind, particularly in the rural areas and developing countries, WMO has elaborated a projec with the support of UN Environmental Programme, concerning the meteorological aspects of the utilization of the radiation and wind energy.

To assist developing countries in preparing a sound meteorological basis for consideration of local climatic conditions, WMO experts are sent, on request, to provide the required advice.

14. Food & Agricultural Organization (FAO)
 of the United Nations,
 Via delle Terme di Caracalla,
 00100 Rome,
 Italy.

 Telephone : 57971 Cable: 'FOODAGRI ROME'
 Telex: 61181 FOODAGRI

 Contact : H.J. von Huelst, Chief Agricultural
 Engineering Service.

The main emphasis of FAO's energy activities is the introduction and extension of proven or promising technologies in developing countries. FAO has published a book 'Energy for World Agriculture' which includes a section on wind energy.

AUSTRALIA

General meteorological data and basic theoretical meteorology suggest that regions of high wind-energy potential exist around the coasts of the Great Australian Bight, the south-west of Western Australia, part of Victoria and the west of Tasmania. It has been suggested that the south-west coast of Western Australia between Cape Naturaliste and Albany might support an annual average wind power of about 280 MW, assuming two lines of MW rated aerogenerators About 2000 km of South Australia coastline might support an annual average wind power of about 2000 MW, again assuming two lines of MW rated generators. The northern part of Tasmania's west coast might support an average power of 200-400 MW.

Australian energy research, development and demonstration grants have been offered to the following current projects :

1) Integration of wind power on a large scale into state electricity grids with short term storage carried out by Commonwealth Scientific and Industrial Research Organization (CSIRO) Division of Mathematics and Statistics, which aims on understanding fully the rate that wind power could play in the large scale generation of electricity in Australia.

2) Vertical Axis Wind Turbine : Carried out by the Flinders University of South Australia, aims to develop, demonstrate and test a simple, inexpensive vertical axis wind turbine.

3) Hybrid photovoltaic, wind generator and diesel generator power supply system for small scale remote area use : Project is under Dunlite Pty. Ltd., to develop and construct a hybrid energy system to supply the electrical needs of a household from wind and solar derived sources. The knowledge gained will result in the development of commercially viable energy packages.

4) Generation of electricity in the tropopause : Carried out by University of Sydney relates to a feasibility study and certain wind tunnel tests.

Australia

5) **Bass Strait wind energy study : Carried out by Hydro-electric Commission of Tasmania with the immediate aim of determining the detailed wind characteristics of the best sites for wind driven generators on King and Flinders Islands.**

Australia has a small commercial industry (notably Dunlite Ltd.) with an international market for manufacture of wind generators (usually about 1 kw). Various projects on the small scale use of wind energy for electric power generation exist in government laboratories, tertiary institutions and private firms.

An Australasian Wind Energy Association is to be set up, the structure of which will be formalized at the first annual general meeting anticipated to be held in December 1980. The Association aims at encouraging wind energy utilization in Australia, New Zealand, and surrounding islands.

1. * Appropriate Technology and Community Environment (APACE),
Box 81, Sydney University Union,
Wentworth Building,
Sydney, New South Wales 2006,
Australia.

Contact : Dr. J.R.E. Waddell, President.

Activities :

APACE is a voluntary organisation, drawing its support and expertise mainly from university staff. Projects underway include :

1) Design of vertical axis windmill.
2) Design of a simple DC/AC inverter.
3) Design of housing complex to be powered by sun, wind and methane biogas.

APACE provides advisory service and plans in future to publish manuals and designs.

Publications :

A newspaper (published three times a year).

Australia

2. * Appropriate Technology Development Group (ATDG),
20, Holdsworth Street,
Woollahrg, New South Wales 2050,
Australia.

Telephone : 32 9705

Contact : Dr. Gordan Innes, President.

Activities :

ATDG was set up in 1976 as a small consulting group to work among developing nations (South Pacific and South East Asian Regions). ATDG provides its members expertise to assist in carrying out appropriate technology projects. Participated in development of a vertical axis wind turbine.

Publications :

Papers on appropriate technology and development.

3. Ballart College of Advanced Education,
Mt. Helen,
Victoria,
Australia 3350.

Telephone : 053 301 800

Contact : Dr. Len J. Cubitt, Lecturer, School of Engineering.

Activities :

Wind energy work commenced in 1976.
Specific activities are :
1) Wind data collection and evaluation.
2) Research and development : developing concrete windmill for farm type applications.

Budget :

$2,000 per annum.

Publications :

Technical reports, research papers.

Australia

Windmill Installations :

Type of installation :	Laboratory scale and demonstration unit.
Type of windmill :	Vertical axis and horizontal axis.
Applications :	Water pumping and power generation.

Personnel :

Dr. Len J. Cubitt and Mr. Les McGrath.

4. Commonwealth Scientific and Industrial Research Organization (CSIRO),
Div. of Mathematics and Statistics,
P.O. Box 1965,
Canberra City, ACT 2601,
Australia.

Telephone : (062) 822011 Telegram : 'MATHSTATS Canberra'
Telex : 62620

Contact : Dr. Mark Diesendorf, Principal Research Scientist.

Activities :

Wind energy work commenced in 1978.
Main activities are :
1) Wind data collection and analysis.
2) Research and development : wind-power assessment for Tasmania, wind-power for Western Australia, environmental impact of wind power. Current project is on the integration of wind power on a large scale into state electricity grids with short term storage.
3) Mathematical modelling and computer simulation of wind energy conversion systems.

Budget :

$23,500 in FY 1979-80.

Australia

Funding Source :

Australian National Energy Research Development and Demonstration Council (NERDDC) and CSIRO.

Publications :

Programme summaries, project evaluation reports, several research papers and technical reports on wind power, reviews/surveys.

Personnel :

Dr. Mark Diesendorf, Mr. John Haslett, and Mr. John Carlin.

5. CSIRO,
Institute of Earth Resources,
Div. of Land Use Research,
P.O. Box 1666,
Canberra City, ACT 2601,
Australia.

Telephone : 464911   Telegram : 'LAND RESEARCH CANBERRA'
Telex : 62337

Contact : J.J. Basinki, Acting Chief of the Division.

Activities :

Main activities are :

1) Wind data collection and analysis : acquisition of meteorological, hydrological, geological and statistical data.
2) Current project titled 'Continental assessment of solar and wind energy potential' is expected to be completed by 1981.

Budget :

$33,000 per annum.

Fundin: Source :

Treasury Trust Govt./Tasmania Energy Authority.

Australia

Publications :

Technical reports (1. 'A Wind Resource Assessment for Papua New Guinea' (1979).
2. 'Water and Air Resources Group Research Project' Jan-May 1980).

Personnel :

Dr. M. Diesendorf, Ms. M. Johnson, and Dr. J. D. Kalma.

6. CSIRO,
Div. of Environmental Mechanics,
P.O. Box 821,
Canberra City, ACT 2601,
Australia.
Telephone : 464911 Telex : 62351

Contact : Dr. E.F. Bradley.

Activities :

Work commenced in 1977.
Main activities :
1) Wind data collection and evaluation.
2) Fundamental research into the characteristic of wind and turbulence over complex and hilly terrain. The results are relevant to the requirement of site selection for wind generator installations and to the mechanical design of the rotor systems.

Publications :

Research papers describing wind characteristics.

7. James Cook University,
Dept. of Civil Systems Engg.,
Townsville, Queensland,
Australia 4814,
Telephone : (077) 814270 Telegram : 'UNITOWN'
Telex : AA 47009

Australia

Contact : Dr. G.R. Walker, Associate Lecturer in Civil Engg

Activities :

Wind data collection and analysis.

Budget :

$1,000 per annum.

Funding Source :

Australian Research Grants Commission.

Publications :

Research papers, reviews/surveys.

Personnel :

Dr. G.R. Walker, and Dr. J.D. Holmes.

8. State Energy Commission of Western Australia,
Box L921 GPO Perth,
Western Australia 6001,
Australia.
Telephone : 3264911 Telex : AA 92674

Contact : T.S. Crawford, Energy Research Engineer.
Barry Wood, Information Officer, SERIWA.

Activities :

Wind energy work commenced in 1980.
Activities include :
1) Wind data collection and evaluation.
2) R&D Projects currently supported by SERIWA
   a) Remote area power supply investigation (3 years beginning in 1979).
   b) Wind generators for Rottnest Island (1980).
   c) Radiation and wind monitoring stations.
3) Technical information dissemination

Budget :

Approx. $200,000 for 1980/81.

Australia

Funding Source :

National Research Development and Demonstration Council, Solar Energy Research Institute of Western Australia; State Energy Commission of Western Australia.

Windmill Installations :

5 kw - Dunlite horizontal axis, demonstration unit.

50 kw - DAF, vertical axis windmill, 50 kw at 13 m/s 20 kw at 10 m/s - Rottnest Icland.

22 kw - .1 MAN horizontal axis windmill, 22 kw at 5 m/s, 20 kw at 10 m/s - Rottnest Island.

Personnel .

T.S. Crawford, and W. Pedrick.

BRAZIL

Extensive analysis of wind data from 42 stations located in North East Brazil exposed the persistant characteristics of the winds that blow there. As only 25% of the hydroelectricity power in Brazil is utilized, a wind plant was planned to be competitive with hydro.

The persistence in direction of the winds has an advantage since it can help reduce the price of the wind plant project. It was estimated in 1976 that if the price of hydro electricity remains U.S. $15/- per MW hour in Brazil, the system would pay for itself within approximately 8 years.

Windmills for pumping have been used in North East Brazil for a long time. However until now, no semi industrial plant has been constructed. The first experience was with a 20-30 kw unit for winds of 7 to 10 m/s. It is a 5 mt, fixed direction windmill. A 20 kw-117 V alternator is available commercially in Brazil.

Brazil imports about 450,000 tonnes of sodium hydroxid per year, also a large amount of the fish catch is actually lost for lack of freezing facilities. Aeolian Energy can be readily used in these cases.

CANADA

Canada now obtains over 10% of her energy supplies from renewable energies. Extensive meteorological studies have shown that while there is an excellent supply of wind available for energy production, it is unevenly distributed.

The National Research Council (NRC) has been assigned for coordination of the Renewable Energy Task which includes The Wind Energy Program. Wind Energy R/D has received about $1 m per annum for the years 1978, 1979 which has increased to $1½ m for 1980.

Wind energy research had begun in Canada long before the formal initiation of the current R/D program. In the early 1960's the Brace Research Institute at McGill University had begun the development of wind machines. In the late 1960's and early 1970's, the vertical axis "Eggbeater" wind turbine had been developed.

The Canadian R/D efforts have concentrated exclusively on the vertical axis wind turbines. Since industrial development and production engineering of the vertical axis wind turbine are considered to offer promise of substantial cost reduction, early emphasis was placed in the Canadian program on the transfer of this technology to Canadian manufacturing industry. It was also recognized early in the Canadian program, that electric power utilities and in particular those operating in parts of the country where large-scale wind energy potential is high should be invited to participate in the program. This led in 1976 to the NRC/Hydro Quebec Magdalen Island wind turbine (capacity 230 kw) project and to subsequent interest by Newfoundland and Labrodar Power and by Saskatchewan Power Corporation in similar, but small scale pilot plants. In Canada industry has continued to make contributions to vertical axis turbine technology and still maintains a lead in this area.

NRC Wind Prospecting project will obtain wind speed measurements at selected sites in different parts of Canada, specifically chosen for their wind energy potential. Equipments were to be procured and installed at chosen sites during 1979/80.

Canada

Development and trial applications of small (100 kw) VA WT are proceeding on two parts. DAF-Indal Ltd., have been awarded contracts for 50 kw machines for application in Canada and the U.S. A hybrid (wind/diesel electric) system utilizing the 50 kw DAF rotor is being installed as a joint venture by Ontario Hydro, the Ontario Ministry of Energy and NRC. This project is seen as a potential prototype of a "stand-alone" power supply for remote communities. The remainder of Canadian installations of 50 kw DAF VAWT's are grid-coupled generators installed as joint projects between NRC and electrical utility companies.

As part of the Renewable Energy Incentives program announced in July 1978, two special projects in wind energy were identified. The first was the installation at Wreck Cove, Nova Scotia, of a wind turbine whose output was to raise water 50 feet from a nearby lake into the 1200 foot head pond of a hydroelectric generating station. The second project was the establishment on Prince Edward Island of an Atlantic Wind Turbine Test Site. NRC is expected to provide both technical guidance and support to both these projects.

1. National Research Council of Canada (NRC),
   Energy R/D Program Branch,
   Bldg. M-50, Montreal Road,
   Ottawa, Ontario,
   Canada K1A 0R6.

   Telephone : 613-993-3405

   Contact : M.S. Chappell, Manager, Wind Energy R/D Programme.

   Activities :

   Canadian R/D in renewable energy began in 1974 and is carried out in the private sectors under contract to the federal government. Current programme structure includes :
   1) Resource assessment.
   2) Technical development of small wind turbines.
   3) Technical development of large wind turbines (Vertical Axis Wind Turbines).

Canada

The near-term objectives of the Wind Energy R/D Programmes are to access, expand and exploit current advances in power generation to contribute to the solution of the energy programme in Canada. In the long term, export markets and industrial benefits will also be significant.

Budget :

Approx. $1.2 m per annum for wind energy R/D program.

Funding Source :

Federal Government.

Publications :

Programme summaries, project evaluation reports, several technical reports ('Renewable Energy Research and Development in Canada' Dec. 1979).

Windmill Installations :

Several laboratory scale, demonstration units and actual use type of installation with a total of 5 grid coupled and 6 stand along units. Mainly vertical axis type of windmills for power generation and cathodic protection of pipeline.

2. University of Calgary,
Dept. of Mechanical Engg.,
Calgary, Alberta T2 N1 N4,
Canada.
Telephone : 403-284-3777 Telex : 038-21545

Contact : Dr. J.A.C. Kentfield, Professor.

Activities :

Wind energy work commenced in 1973.
Main activity is :
1) Research and development of operationally flexible, efficient, low cost and reliable wind turbine (horizontal axis wind turbine, hybrid cyclo-giro-darrieus rotor, delta-wing bladed

wind turbine, ventri-type wind energy concentrators).

Budget :

Approx. $10,000 per annum.

Funding Source :

Algas Resources (Calgary); Abacus Engineering Ltd. (Calgary); University of Calgary.

Publications :

More than 10 research papers and reports on wind turbines for pumping and electricity p... generation.

Windmill Installations :

Type of installations :	Laboratory scale and demonstrat units.
Type of windmills :	Vertical axis (novel form of Giromill 4.6 m x 4.6 m). Horizontal axis (with delta-wing planform blades, rotor-diameter 3.3 m)

Applications .

Water pumping (horizo...al axis) and power generation (vertical axis).

Personnel :

Dr. J.A.C. Kentfield and Mr. D. Bayly.

3. University of Waterloo,
Dept. of Mechanical Engg.,
Ontario,
Canada N2L 3G1.

Telephone : 519-885-1211 Telex : 069 55259

Contact : G.M. Bragg.

Activities :

Research and development (wind powered pumping systems).

Canada

Publications :

Contract reports, research papers, books.

Budget :

$10,000-$50,000 per annum.

Funding Source :

Canadian Govt., International Development Research Centre.

Windmill Installations :

Laboratory scale, vertical and horizontal axis windmills for water pumping.

Personnel :

Varies one to four.

CHINA

The monsoon-swept parts of China have very rich wind resources. Surveys show that wind energy is mainly distributed over the vast grasslands on the Qinghai-Tibet Plateau and the Inner Mongolia Highlands and along the south-east coast. The annual mean windspeed in the pastoral areas is 4-4.5 m/s. In coastal areas of Zhejiiang and Fujian provinces in east China, wind with a velocity over 8 m/s blows for 5500 h/year. Exploiting such favourable natural condition and developing wind power generation is an important way to achieve electrification in these areas.

The experimental wind-power stations have been listed as a major scientific research item in China. The Chinese Ministry of Power Industry has set as a goal the production and popularisation of small wind-driven generators which are reliable, simple and inexpensive and which are in line with China's technological and physical capabilities.

An 18 kw prototype wind turbine generator has been installed at Sijiao Island, off the east coast of China and is working well since it was installed last year. The turbine rotor of 13 m diameter starts generating when the wind velocity reaches 4 m/s and operates at full capacity when the velocity reaches 8 m/s.

The wind driven generating unit is the biggest of its kind designed and made so far in China. In addition to lighting fishermen's households on the island, it supplies power for 1 m^3/h desalination and for electric welding. Based on the operating experience of this test set the Zhejiang provincial machine building department is now designing and manufacturing 40 kw wind turbine generators.

A 2 kw wind turbine-generator with three steel blades 4 m in diameter installed on a 9 m high tower has been operating for more than a year at a remote railway station located in Xinjiang's Turpan Depression. The wind turbine generator supplies electricity for the railway station's signalling and lighting systems and nearby households.

Several hundered wind driven generators, with capacities between 100 W and 250 W have been made in Inner Mongolia, Shanghai, and Heilongjiang. Small wind-power generators each with a capacity of 2 kw are in trial operation on the grasslands of Inner Mongolia, Gansu and Heilongjiang provinces.

China

The Ministry of Power Industry and its research institution are continuing their experiments with medium sized generating units so as to standardise and perfect them to meet the pressing needs for electricity in remote areas.

DENMARK

The Danish wind power programme is being undertaken by the Ministry of Commerce in collaboration with the electric utility companies.

The growth in interest in wind power has been shown by (1) reports from Danish Academy of Technical Sciences (1975), (2) the construction, mainly by individuals of a number of small wind generators, five of which have been connected to the grid, (3) the renovation of the 200 kW Gedser wind generator jointly by ERDA of the U.S.A. and DEFG, the research organisation of the Danish electricity utilities (from 1957 to 1967 this machine had operated successfully while coupled to the grid), (4) significant papers from the Niel Bohr Institute on the amount of wind power capacity that can be inserted into a conventional electricity grid and on the role of short term storage in improving the availability of power from a set of wind generators at a single site.

Over the two years from December 1976, the Danish government has appropriated 14.26 M DKr. ($2.4 M) and the DEFG 3 M DKr. towards a development program for medium-to-large wind generators.

Two windmills are being constructed at Nibe in Denmark, each with a triple-bladed 40 m diameter rotar and a design speed of 34 rpm, with maximum output 630 kW.

The world's largest wind generator, the Tvindmill, stands at Tvind, 10 km from the North Sea coast of Denmark began operating in 1978. Testing and proving of this 54 m three blade, community financed and built 'Tvindmill' have been completed successfully. The output is currently limited to 500 kw instead of its full rated power of 2 MW. .

Research and development in Denmark is being carried out in 3 major areas ·

1. Assessment of wind resources.
2. Large Wind Machines : Design, construction and operation of large conversion systems (600 kw); wind profiles; motor design and siting studies for 1000-2000 systems.

Denmark

3. Small Wind Machines : Field tests of small windmills; combination of windmills and torque converters; wind power for heating agricultural estates; integrated wind power heating scheme.

1. Institute of Agricultural Engineering,
Royal Agricultural University,
Agrouejlo, D K 2630,
Taastrup,
Denmark.

Telephone : (02) 992613

Contact : Mr. Richard Matzen, Asst. Prof.

Activities :

Work commenced in 1973.
Main activity is converting wind energy into heat, development of water-brakes.

Funding Source :

University Research.

Publications :

Technical reports and research papers ('Wind Energy - Heat Generation (Publ. 1978)').

Windmill Installations :

Demonstration units and actually operating horizontal axis windmills for heat generation and agricultural tasks.

Personnel :

Mr. Richard Matzen, and Mr. S. Sonne Kofoed.

Denmark

2. * Riso National Laboratory,
DK-4000 Rosklide,
Denmark.

Contact : Helge Peterson.

Activities :

1. The main activity of RISO National Lab. is to establish and run a test plant for small windmills. Planning of the plant was initiated in 1978. 7 platforms for windmills have been erected and the data sampling and handling system had been completed and tested.
2. RISO also offers consulting assistance to designers (given free of charge to manufacturers).

Budget :

Danish Kr. 5.5 million for period of 3 years ending in the beginning of 1981.

Funding Source :

Ministry of Energy.

Publications :

Research papers, reports ('Small Windmills in Denmark' (Feb. 1980) describes completely the project for small windmills funded by the Ministry of Energy, with a survey of Danish windmills).

Personnel :

Staff of the test plant consists of 2 academic engineers and 2 technicians. A group of 4 more academic engineers is associated with the test plant performance development work and production cost analyses based on windmill experience at the test plant.

FEDERAL REPUBLIC OF GERMANY (FRG)

Meteorological data and analysis indicate that the maximum technical potential of wind energy in FRG is 220 Twh/yr.

Research and development in FRG have been carried out on three lines :

1. Acquisition and processing of wind data; meteorological measurements; wind condition in FRG.
2. High Capacity Power Plants : Development, construction and testing of a 52 m rotor diameter prototype (265 kw). Engineering study of a 1-2 MW power plant, design, storage systems, rotor blades, dynamic behaviour.
3. Small Wind Power Systems : Development of 5.5 m rotor diameter vertical axis converter; evaluation of 15 kw power plant.

The West Germany Ministry for Research and Technology (BMFT) for the purpose of wind energy research granted DM 100 million. One of the major research project of West Germany was to work on the large scale wind energy plant "Growian" one of the world's largest modern windmill. The windmill developed by the firm Maschinenfabrik Augsburg-Nurn-berg in cooperation with Stuttgart University, Kassel College and the German Air Space Research and Experimental Institute in Cologne will be capable of producing 3 MW of electricity.

The project also includes construction of 5 smaller wind power plants, each with an output of 10 kw near the Elbe river. A medium size plant with a capacity of 270 kw developed by Voith (Heidenheim) was to be erected in the Swabian Alb region.

1. Deutsche Gesellschaft Fur Sonnenergie,
Goethestr 28,
8, Munchen 2, Postfach 200604,
Federal Republic of Germany.

Telephone : 089/530414

Federal Republic of Germany (FRG)

Activities :

Work commenced in 1977.
Main activities are :
1) Wind data collection and evaluation.
2) Research and development.
3) Extension/promotion.

Publications :

Publication lists, research papers.

Budget :

DM 300,000 per annum (for total solar energy programme).

Funding Source :

Membership fees.

2. Technische Universitat Berlin,
Interdisziplinare Projektgruppe fur
Angepasste Technologie,
Lentzeallee 86-D-100, Berlin 33,
Federal Republic of Germany.

Telephone : (030) 314 7337

Activities :

Wind energy work commenced in 1975.
Specific activities are :
1) Research and development : Flapping vane wind pump.
2) Production and marketing.

Publications :

Programme summaries.

Budget :

DM 600,000 per annum.

Funding Source :

GTZ, German Technology Exchange; University of Berlin.

Federal Republic of Germany (FRG)

Windmill Installations :

Demonstration units of vertical axis, horizontal axis windmills and flapping vane wind pump, for water pumping.

FRANCE

Studies by the Electricite de France indicated that France is well endowed with a large number of potential wind electric conversion sites. There are several sites at 40 m height above ground where annual power in France exceeds 3000 kWh/m^2.

The French built and operated several large and medium scale wind powered electric generators in the period from 1958 to 1966. These included three horizontal-axis units, each witn three propeller type blades. A unit of this type was operated intermittently near Paris from 1958 to 1963. This unit was designed to generate 800 kw in winds of 37 mph. Two other units were constructed at St. Remy-des-Landes in Southern France. The larger of these units was rated at 1000 kw in winds of 37 mph. At present no effective research program has been established.

A new concept the flexible blade windmill (FBW) was developed in France through a joint Industry-University programme.

Both France and Switzerland are notable for the long-established manufacture of small-scale wind plant, at present up to 10 m diameter with current design activity in a higher range to meet developing autonomous market needs.

1. Group Eneole,
A.D.E.R. Languedoc Roussillon,
Universite des Sciences et Techniques Languedec,
34060 Montpellier, Cedex,
France.

Telephone : (67) 63-42-15

Contact : H. Guastalla, Secretary of the Group.
M. Charles, President of A.D.E.R.

Activities :

1) Wind data collection and analysis.
2) Research and development (fabrication of prototypes for actual use).

France

Publications :

Technical reports.

Windmill Installations :

Laboratory scale and demonstration (model under construction), horizontal axis windmill for water pumping and power generation.

GREECE

Evidence of the availability of wind power in Greece is provided by the large number of wind motors which have been used extensively to grind cereals, press olive oil and pump water. These machines are either multivane farm fans introduced from the United States at the turn of the century, or Mediterranean sail windmills which are largely developed in Greece and have been used for several centuries. At least 6,000 of the later are still in use in the plain of Lassithion and several hundred are also used on the smaller Aegean islands.

In order to quantify the wind energy potential and to provide a basis for wind turbine selection and for cost calculations, wind statistics were obtained from the National Meteorological Service of Greece. The maximum available energy is highest in Amarillo (1919 kwh/m^2), Dodge City (1609 kwh/m^2) and Clayton (1601 kwh/m^2). Since this region is considered to be among the windiest areas of the world (Clayton was the first site chosen for field testing of ERDA's 200 kw wind turbine) it becomes quite obvious that the wind in Greece contains substantial amounts of energy which can be used to decrease her dependence on imported oil.

The available wind energy is highest on the Aegean islands. The combination of small electrical loads, high generation costs and considerable amounts of available wind energy suggested that prototype units be installed and monitored on Kythera, Naxos, Skyros, Kos Milos and Samos (Aegean Islands). Studies have been made on the characteristics and performance of the proposed WTGs for the above 6 islands.

Search for windy sites on the mainland needs to be given attention in Greece.

INDIA

Data collected at more than 200 meteorological stations in India indicate that windspeed at nearly 10% of the stations have averaged more than 12 km/hr on an annual basic and that there are as many inland windy locations as coastal ones.

Attempts to utilize wind power in India began in 1950s. In 1952 a wind power sub-committee was constituted under the Council of Scientific and Industrial Research, New Delhi. This committee recommended conducting wind surveys at several locations, adapting a suitable windmill originally developed abroad, and simultaneously taking steps to design a windmill indigenously.

About 160 water-pumping windmills of the Southern Cross type were imported in the late fifties and installed at several locations in the country. During 1959-64 period, the windmill WP-2, developed at National Aeronautical Laboratory, was produced in batches and about 80 of these were erected for field trials at several places in the country. A few electricity generating windmills such as 'Algaier', 'Dunlite', and 'Elektro' were also tested for performance in Indian winds.

Since 1973, following developments are taking place:

1) A few groups in India are constructing prototypes of Darrieus Rotors. At Bharat Heavy Electricals Ltd., Hyderabad, and Indian Institute of Technology, Madras, projects have been initiated for developing a Darrieus rotor for generating electricity at around 1-5 kw capacity. National Aeronautical Lab. programme is directed towards studying a parallel-blade variation of the Darrieus rotor.

2) Another line of development has followed the route of the Savonius rotor. The Application of Science and Technology in Rural Areas (ASTRA) Cell at Indian Institute of Science, Bangalore, has developed a modified design of the Savonius rotor, using wood, iron wires and cloth.

3) The third line of experiments has gone in the direction of the Cretan Sail Windmill. A sail windmill having a rotor diameter of 10 m was erected at Madurai in 1974 to pump water with the help of a reciprocating pump.

India

The ANILA WINDMILL designed and developed at Sri Murugappa Chettiar Research Centre bagged the Independence Day Invention Award of the National Research Development Corp. of India, 1979. Another significant work was at Indian Institute of Technology which developed a Wind Dial for measuring wind velocity and energy content under rural field conditions.

1. Aligarh Muslim University,
   Z.H. Engineering College,
   Mechanical Engg.Dept.,
   Aligarh.

   Telephone : 5970

   Contact : Prof. S. Aktar Husain.

   Activities :

   Wind energy work began in 1978.
   Present activities are training and policy formulation.
   In future, plans are to develop windmills for water lifting and power generation.

   Funding Source :

   Aligarh Muslim University; University Grants Commission, Delhi.

   Publications :

   Research papers ('Wind power for bird scarer to be used in orchards and grain fields' (1978); 'Comfortable heating and cooling by solar reflectors and wind' 1978).

   Windmill Installations :

   Laboratory model for power generation and water pumping (one each).

   Personnel :

   Prof. S. Akhtar Husain, Mr. Wasim Abbas (lecturer), Mr. F.A. Ansari (lecturer), and students (full time).

India

2. Appropriate Technology Development Association,
Project Division,
P.O. Box 311, Gandhi Bhavan,
Lucknow 226 001.

Telephone : 33496, 31478 Telex : 276 GPO Lucknow

Contact : Mr. M.K. Garg.

Activities :

Wind energy development in preliminary stage.

3. Bharat Heavy Electricals Ltd.,
Corporate R&D Division,
Vikas Nagar,
Hyderabad 500 593.

Telephone : 261988 Telegram : BHELDEV
Telex : 015-404

Contact : Dr. R.P. Gupta, Deputy Manager.

Activities :

Work commenced in 1977.
Specific activities include :
1) Development of vertical axis wind turbine of Darrieus type for electric power generation (1976-1980).
2) Development of vertical axis water-pumping windmills (1978-1982).
3) Vertical axis vortex turbine for power generation (1979-1980).

Budget :

About Rs. 1 million per annum.

Funding Source :

BHEL; Dept. of Science and Technology, Govt. of

Publications :

Over 10 papers on various topics of wind energy.

India

Windmill Installations :

Type of installations : Demonstration unit and actual use.
Type of windmill : Vertical axis, horizontal axis and other types.
Applications : Water pumping and power generation.

Personnel :

Mr. S.C. Mantrawadi and Mr. S.K. Chandra.

4. Central Arid Zone Research Institute (CAZRI),
Jodhpur 342 003.

Telephone : 23980 Telegram : 'ARIDZONE'

Contact : S.C. Chowdhry, Scientist-in-charge, Wind Power Utilization Section.

Activities :

Work commenced in 1974.
1) Analysis of wind data from utilization point of view.
2) Research and development (sail wing, water pumping windmill).

Budget :

Rs. 40,000 per annum.

Funding Source :

Indian Council of Agricultural Research, New Delhi.

Publications :

Books, monographs and research papers on wind energy utilization for water pumping.

Windmill Specifications :

Horizontal axis, sailwing windmill for pumping water.
Rotor diameter : 6.7 m
No. of blades : 3

India

Material of blade : Canvas cloth (sail wings)
Cut-in-windspeed : 8 km/hr.
Tower : Wooden.
Tower height : 5.8 m

Pump : Reciprocating type.
Stroke : 22.5 cm.
Cylinder material : Brass.
Special feature : Auto directional assembly with krank.

Pumping capacity :

Wind Speed	Water Output	Depth
15-20 km/hr	1050 litres/hr	3.5 m
26 km/hr	1225 litres/hr	3.5 m

Personnel :

S.C. Chowdhry, Mr. P. Sharma.

5. Central Salt & Marine Chemicals Research Institute,
Gijubhai Badhekar Marg,
Bhavnagar 364 002.

Telephone : 4497/3960 Telegram : 'NAMEK'
Telex : 0162-230

Contact : K.S. Rao, Deputy Director.

Activities :

Work initiated in 1977.

1) Research and development : Wind power utilization in salt industry, developing pumping sprinkler system with wind energy.
2) Design and fabrications : Vertical axis windmill and horizontal axis windmill.

Budget :

Rs. 75,000 per annum.

Funding Source :

Council of Scientific and Industrial Research, New Delhi.

India

Publications :

Technical reports ('Windmills for Salt Industry and for Water Pumping').

Windmill Installations :

Horizontal Axis Windmill :	1 prototype 2 m diameter rotor
Vertical Axis Windmill :	2 m rotor diameter, reciprocating pump, installed at Åwania village.
'1 WINDCHARGER':	Being used for charging car batteries.
Rotor diameter :	1.75 m.
No. of blades :	2.
Blade material :	Wood.
Governing :	Air brake.
Cut-in-speed :	11.8 mt/sec.
Generator :	DC 12 V.
Max. Output :	200 W.
Tower height :	3 m.

Personnel :

Mr. K.M. Majeethia, Mr. B.G. Thaker, and Mr. H.M. Gohil.

6. Indian Institute of Science,
Dept. of Aeronautical Engg.,
Bangalore 560 012.

Telephone : 34411 Telegram : 'AERONAUTICS, SCIENCE BANGALORE'

Contact : Dr. S.P. Govindaraju, Asst. Prof.

Activities :

Wind energy work commenced in 1975.
Activities :

1) Wind data collection and evaluation.
2) Formulation of wind energy programme for Karnataka State.
3) Research : Development of windmills, testing of various types of wind rotors and optimisation of sail shapes; design and development of a load-

matching device to match the load between the windmill pump. Development of anemometer.

4) Designed a low-cost Savonius type windmill for rural use (lifting water). Studies on horizontal axis windmills.

Publications :

Reports and research papers on water pumping wind-mills, rotors, pumps. ('Prospects for Wind Energy Utilization in Karnataka State' (March 1980); 'A Low Cost Water Pumping Windmill using a Sail Type Savonius Rotor'(1979)).

Budget :

About Rs. 50,000 per year.

Funding Source :

Tata Energy Research Institute, Bombay.

Windmill Installations :

Vertical axis windmill with novel sail type construction, was installed at Ungra, began operation in 1977. Pumps water at an average of 2500 litres/day.

7. Indian Institute of Technology,
Hauz Khas,
New Delhi 110 016.

Telephone : 653458 Telegram : 'TECHNOLOGY'

Contact : Dr. K.S. Shishodia, Asst. Prof., Applied Mechanics Dept.

Activities :

Research and development : Wind turbines and instruments for velocity and turbulence.

Budget :

Small amount.

India

Funding Source :

Indian Institute of Technology, Delhi.

Windmill Installations :

Laboratory scale, vertical axis windmills for water pumping application.

Personnel :

Prof. K.L. Kumar, and Dr. A.K. Raghav.

8. Indian Institute of Technology,
Powai,
Bombay 400 076.

Telephone : 581 421 Telegram : 'TECHNOLOGY'
Telex : 011-2385

Contact : Dr. B.S. Jagadish, Prof., Dept. of Mech. Engg.

Activities :

Research and development : Development of ½ kw rating windmills; design/development of sail type windmill for water pump .g.

Funding Source :

Dept. of Science and Technology.

Publications :

Technical reports.

Windmill Installations :

Demonstration units of horizontal axis and vertical axis windmill for water pumping and power generation.

India

9. Jyoti Ltd.,
Energy Div.,
Tandalja,
Baroda 391 410.

Telephone : 66445, 66417

Telegram : 'JYOTI PUMPS'
Telex : 0175-214

Contact : Dr. B.C. Jain, Manager, Energy Div.

Activities :

Established in 1978.
Activities are :
1) Research and development in Wind Energy
2) Production and Marketing : Products manufactured - 3 systems (40 w, 350 w and 1 kw machines).

Budget :

Rs. 1.25 lacs per annum.

Funding Source :

Jyoti Ltd.

Publications :

Specification sheets ('Jyoti Wind Energy Conversion Systems').

Windmill Specifications :

	40 w	350 w	1 kw
No. of blades	2	3	3
Blade material	wood	-	-
Cut-in windspeed	8 kmph	8 kmph	8 kmph
Governing	manual brake	manual brake	manual br[illegible]
Transmission	direct drive		
Maximum output at 16 kmph	40 w	350 w	1 kw
Generator	D.C.	A.C.	A.C.
Applications	Battery charger	Village water supply and rural lighting	

India

10. Karnataka Regional Engineering College,
Dept. of Mechanical Engg.,
Surathkal 574 157.

Telephone : 8665 to 8669 Telegram : KARENG

Contact : S. Surendra Shenoy, Asst. Prof.

Activities :

Wind energy work commenced in 1978.
Main activity is :
Research and development of water pumping windmills

Budget :

Rs. 1,000/- per annum.

Funding Source :

From the college itself.

Publications :

Research papers (wind turbines).

Windmill Installations :

Laboratory scale, vertical axis and horizontal axis water pumping windmills.

Personnel :

Prof. S. Krishna Setty, Prof. B.S. Samaga, and Shri S. Upendra Shenoy.

11. National Aeronautical Laboratory,
Post Bag No. 1779,
Bangalore 560 017.

Telephone : 53351 Telegram : 'NAEROLAB'
Telex : BE 279

Contact : Dr. S.K. Tewari, Scientist.

India

Activities :

Involved in wind energy field since 1950s.
Activities include :

1) Wind data collection and evaluation.
2) Economic studies of wind energy for India.
3) Research and development (windmills for pumping water).
4) Production and marketing : Two types of standard horizontal axis windmills have been developed - WP1 and WP2.
5) Extension/promotion.
6) Policy formulation/program evaluation.

Budget :

Rs. 4 lakhs for a project (1979-82).

Funding Source :

Dept. of Science and Technology, Delhi.

Publications :

Technical reports and several research papers. ('Wind energy programme at National Aeronautical Lab., 1979'; 'A methodology for evaluating appropriateness of wind energy resources in rural application' (1979); 'Economics of wind energy use for irrigation in India' (1978)).

Windmill Specifications :

Two standard horizontal windmills.
WP1 - for highly windy sites.
WP2 - for moderately windy sites.
A prototype of 10 m sail windmill (6 sails) is installed at NAL Campus. Tower height is 12 m. The windmill is expected to irrigate 1 hectare of land in an area with wind velocities averaging 10 km/hr for 10 hrs per day.

Personnel :

Mr. A.R. Venkatanarayana, Mr. M.P. Ramesh (Scientist) and 4 technical staff.

India

12. Sri A.M.M. Murugappa Chettiar Research Centre (MCRC),
Photosynthesis & Energy Div.,
Tharamani,
Madras 600 042.

Telephone : 411 937 Telegram : 'WELDABLE'
Telex : MCRC CARE-TUBIND-64101

Contact : Dr. C.V. Seshadri, Director.
V. Geethaguru, Research Technologist.

Activities :

The Photosynthesis and Energy Division of MCRC was established in June 1977 as a non-profit research institute funded by a group of companies.

1) Research and development : Wind powered devices for use along 900 km long Coromandal Coast of Tamil Nadu and for use in the interior areas.

2) Design and fabrication : Two significant windmills designed at MCRC are ANILA I (unidirectional) and POGHIL (multidirectional).

Budget :

Rs. 1½ lacs (for the whole institution).

Funding Source :

M/s. Carborandum Universal Ltd.; Tube Investment of India Ltd., Madras; United Nations University; International Federation of Institutes of Advanced Study (IFIAS).

Publications :

'Technical Notes No. 6 : A Three Year Review June 1980.' Detailed construction booklet for ANILA windmill (plans to prepare booklet for POGHIL windmill also).

India

15. **Tool-ORP Windmill Project,**
Vill. Kusumih Kalan,
Post Box No. 62,
Ghazipur 233 001.

Contact : Major P. Sharan, General Manager.

Activities :

This project commenced in 1977 with current activities as under :

1) Wind data collection and evaluation.
2) Research and development : The organization has a research section located at Allahabad Polytechnic (U. P.). During 1978-1979, windmills were being experimented.
3) Production and marketing : Since beginning of 1980 windmills are manufactured for commercial sale.
4) Training courses in windmill technology at engineer's and mechanic's levels are organized every year.

Publications :

Technical reports, publicity brochures.

Budget :

Rs. 25, 52, 000 for the project.

Funding Source :

Govt. of Holland (Tool-Foundation); Govt. of India (PADI) and Organization of Rural Poor, Ghazipur.

Annual Earning :

In 1980 - Rs. 50, 000 till October from sale of windmills.

Windmill Specifications :

(Horizontal axis water pumping windmill).

Rotor diameter :	5 m.
No. of blades :	12.
Windspeed :	Can operate in windspeeds as low as 2.5 m/s.

India

Material of the windmill :	Basic structure is steel. Nylon bearing, wood and PVC pipes.
Storage tank :	Size 10 x 10 x 1.5 m.
Tower height :	7 m.
Windmill weight :	400 kg.
Capacity :	4 litres/sec. Pumps wate by which 1.2-1.4 hectare of land can be irrigated throughout the year.
Price :	Rs. 5,500.

A smaller type of windmill (2 m rotor diameter) has been designed by TOOL-ORP for low lift irrigation.

16. University of Jodhpur,
Dept. of Mechanical Engg.,
Jodhpur.
Telephone : 22790 Telegram : 'ENGCOL'

Contact : Dr. M.L. Mathur, Prof. & Head of the Dept.

Activities :

Research on Savonius Rotor.

17. University of Roorkee,
Dept. of Physics,
Roorkee 247 672.

Contact : Prof. N.C. Varshaneya.

Activities :

Wind energy work commenced in 1980.
Specific activities include :
1) Investigation to increase windspeed through escarpments undertaken and results communicated.
2) Locating regions for optimum utilization of wind energy in India. Wind energy potentials

have been surveyed for 7 states: A.P., Tamil Nadu, Gujarat, Rajasthan, Maharashtra, Kerela, Orissa. Studies on other states are underway.

3) Plans to install a windmill in Roorkee University Campus.

Budget :

Rs. 800. Proposes to spend Rs. 7,500 towards windmills.

Funding Source :

University of Roorkee.

Publications :

Over 9 papers on wind energy utilization and potentials in different states of India (published in 1980.. Two papers to be presented at conferences held in 1981).

Personnel :

A. Jagadeesh, Teacher Fellow, and Dr. Ishwar Chand, Scientist.

18. Voltas Ltd.,
19, J.N. Heredia Marg,
Ballard Estate,
Post Box No. 900,
Bombay 400 038.

Telephone : 268131 Telegram : 'VOLTAIP'
Telex : 2239/3054

Contact : Mr. R.S. Iyer, Development Manager, Agro-Industrial Products Div.

Activities :

Wind energy work commenced in 1979.

1) Research and development.
2) Production and marketing . Prototypes made are based on the design of Intermediate Technology Development Group, London. Studies, tests are being conducted to make the windmill better suited for working in Indian conditions.

India

Funding Source :

Voltas Ltd.

Windmill Installations :

Demonstration model, horizontal axis, water pumping windmills.

Personnel :

Mr. S.H. Dairkee, Mr. S.N. Tripathi, Mr. S.S. Oak and Mr. A.D. Mane.

19. Water and Mineral Exploration Research Training Institute
1-36, Z.P. Street No. 6,
Tarnaka,
Hyderabad 500 007.

Telephone : 71565

Contact : Mr. K.A.S. Mani.

Activities :

Work commenced in 1980.
Main activity is :.
Assembling a low-cost windmill to lift water from open wells for irrigation purpose, using material, skills and tools locally available at the village. In future, efforts will be made to improve the efficiency at comparatively low wind velocities.

Budget :

1980 - Rs. 10,000.

Funding Source :

Water Development Society.

Windmill Installations :

Demonstration unit of horizontal axis windmill for water pumping.

Personnel :

Mr. K.A.S. Mani, Mr. David Comfort, and Mr. Janardhan.

IRAN

1. Shiraz University,
Dept. of Mechanical Engg.,
Shiraz,
Iran.

Telephone : 37852

Contact : Dr. Goodarz Ahmadi, Prof.

Activities :

Work initiated in 1976.
Specific activities are :
1) Wind data collection and evaluation.
2) Research and development : Elastic wind wind energy converter, development of small vertical axis cylindrical wind turbine, testing of a model of Persian windmill.

Budget :

$9,000 (amount for 2 years).

Funding Source :

Shiraz University Research Council.

Publications :

Technical reports and research papers.

Windmill Installations :

Laboratory scale vertical axis and horizontal axis windmills for water pumping and power generation.

Personnel :

Dr. A. Sabzevari, Dr. M. Yaghabi, Dr. G. Ahmadi, several technicians and students.

ISRAEL

1. Ben-Gurion University of the Negev,
P.O. Box 653,
Beersheva 84120,
Israel.

Telephone : 051-61398

Contact : Dr. Ozer Igra.

Activities :

Research and development started in 1974. Several studies have been conducted on shrouded aerogenerators (design, construction and performance); cost-effectiveness of vortex augmented wind turbine.

Funding Source :

The U.S. -Israel Bi-National Science Foundation; Jerusalem and the Israel Ministry of Energy.

Publications :

More than 7 research papers on shrouds and shrouded wind turbines.

Windmill Installations :

- Laboratory scale and demonstration units of horizontal axis windmill for power generation.

JAPAN

It is reported that approximately 10% of the present total power consumption may be obtained from the winds. The development of a unique wind power utilization system suitable for Japan is highly expected.

Among the "Sunshine Schemes" planned by the Ministry of International Trade and Industry (MITI) study committee for wind energy systems was established in 1977, and at the Science and Technology Agency, a special study committee was set up and the report on the study for wind energy utilization was made and the preparation of a concrete wind energy utilization project is now underway. In 1977, the Japan Wind Energy Association was established. Thus the R&D system for the wind power utilization in Japan has gradually been consolidated jointly with governmental and private efforts.

A NU-101 axil flow type wind turbine was built in 1973 for electric power generation at observation base in Antarctic Continent. A wind power generation system for a beacon developed at the maritime safety test center of the Maritime Safety Agency was installed in 1976. It is of a 5 blade propeller type with a diameter of 2.25 m design paint wind velocity of 4.5 m/sec and power output of 30 W.

A propeller type wind power generator was developed by the Japan Telephone and Telegraph Corp. in 1977. Its propeller diameter is 8 m and its output is 8 kw. The first Darrieus type windmill in Japan was also developed by the Japan Telephone and Telegraph Corp. in 1977. It has a maximum blade diameter of 8 m and output capacity of 2 kw.

A Giromill type experimental wind turbine was developed by the Iwanaka Electric Works Ltd. Another Giromill type windmill was developed by Mr. Seki's group of Tokai University which had an output of 30 W.

A prototype "Kaifu No. 1" with a twin rotor tilting type windmill was developed and field tested in 1978.

Japan

A number of unique wind energy systems are being developed at various industrial firms and universities. Also large number of amaeteurs throughout Japan are trying to manufacture unique windmills with various devices.

Present study of wind energy systems comprise the following subjects :

1. Meteorological and environmental assessment.
2. Preparation of model for the determination of suitable site conditions.
3. Design of 300 MW output plant.
4. Design of experimental 3 MW component.

NETHERLANDS

In the middle of last century, there were 9000 windmills in Netherlands. At the moment about 900 windmills are left, but only very few are operational.

An estimate of the potentiality of wind energy in the Netherlands indicates that about 20% of the present day electricity production could be obtained from the winds.

In 1975, a Project Evaluation Group prepared a proposal for a research and development programme on wind energy. The Government decided to have this programme executed, starting on March 1976. In Netherlands, two research programmes are presently carried out in the field of wind energy :

1) A National Programme on Wind Energy : This is to investigate the possibilities of using wind energy as a source of power for the Netherlands.
2) A Programme on Wind Energy for Developing Countries : This is community study on possible use of wind energy in rural areas of developing countries.

Current research programme includes detailed meteorological studies in the North Sea as well as analysis of weather data from measurements from the coastal regions.

A 5 m diameter Darrieus wind turbine was designed, constructed and put into operation in 1977. The turbine located at Netherlands Aircraft Factories Fokker-VFW has an output of 1.8 kw at 7 m/sec windspeed and 15 kw at 14 m/sec windspeed.

A new programme that was included in the national programme concerned the study of the effect of tip-vanes (small additional wings, mounted at the end of the rotor blades) on the efficiency of horizontal axis turbines.

Netherlands

At present official R&D policy concerning wind energy is focussed on very large systems, like rotors with a span of 50 meters. There are plans for "Wind turbines at the North east Coast and I. Jssellake. 5000 of these giant mills would be able to supply 10-15% of the country's current electricity demand. The next 5 years (1981-1986) of the National Research Programmes on Wind Energy will pay more attention to R&D with small 5-10 meter turbine. These will be used by the government to dewater the polders and by fruit growers to cool their products.

List of institutes and industries involved in the execution of the national research programme on wind energy :

Institute of Industry	Research and Development Activities
KNMI (Royal Nederlands Meteorological Institute)	Determination of wind characteristics.
Fokker Aircraft	Operation of a vertical axis rotor wind turbine unit (rotordiameter 5 m). Development of economic fabrication methods for rotor blades.
NLR (National Aerospace Laboratory)	Development of computer programme for parametric investigations of the performance and aero-elastic behaviour of windturbine rotor systems.
FDO-Engineering Consultants B.V.	Design, fabrication and assembly of a medium scale horizontal axis windturbine. (rotordiameter 25 m).
Eindhoven University of Technology	Development of electric systems for the conversion of mechanical into electrical energy.
Smit Slikkerveer	Evaluation of electric systems for the conversion of mechanical energy into 50 cycle a.c. power to be fed into the utility grid.

Netherlands

Institute of Industry	Research and Development Activities
MT-TNO	Study on wake interactions of wind-turbine clusters.
Delft University of Technology	Investigation of the tip-vane concept.
Rijn-Schelde-Verolme	Study of wind turbines located off-shore.
Rademakers Aandrijvingen	Development of a epicyclic gear system for the conversion of a variable rotor speed to a constant generator speed.
KEMA (Utility board)	Integration of wind energy conversion system into the existing utility grid.
ECN (Netherlands Energy Research Foundation)	Project Management. Evaluation of programme results. Literature research and documentation.

1. Institute for Applied Scientific Research, TNO,
   Post Box 340, 7300 AH,
   Apeldoorn,
   The Netherlands.

   Telephone : 0055-773344 Telex : 36395 TNO AP

   Contact : Dr. Peter Builtjes.

   Activities :

   Wind energy work commenced in 1976.
   1) meteorological studies.
   2) Research and development : Study on wake interaction of windturbine clusters.
   3) Application studies concerning wind farms.

Netherlands

Budget :

Dfl 150,000 per annum.

Funding Source :

Dutch Government and International Energy Agency.

Publications :

Research papers. ('An Experimental Analysis of Wind Turbine Wakes' (1980); 'Modelling of Wind Turbine Arrays' (1980)).

Personnel :

Dr. Peter Builtjes and Mr. Paul Vermeulen (Dept. of Fluid Flow Technology).

2. Steering Committee on Wind Energy Developing For Countries (SWD),
C/o DHV Consulting Engineers,
P.O. Box 85, 3800 AB Amerfoort,
The Netherlands.

Telephone : 033-682 480

Contact : U.P.T. Smulders.

Activities :

SWD was established in July 1975 by Netherlands' Ministry for Development Cooperation.
Activities are :

1) Assisting wind energy projects in developing countries. Currently assisting Sri Lanka, Tunisia, Republic of Cape Verde, Pakistan and Sahel.
2) Wind energy research and development undertaken in Netherlands.
3) Transfer of knowledge on wind energy use.
4) Production and marketing (non-commercial).

Publications :

Technical reports. Together with Tool Foundation, SWD publishes the 'Sun and Wind Compendium' completely devoted to the pumping of water with solar and wind energy.

Budget :

$1000,000.

Funding Source :

Ministry of Development Cooperation, The Netherlands.

3. Workgroup on Development Techniques (WOT),
Twente University of Technology,
P.O. Box 217,
7500 AE Enschede,
The Netherlands.

Telephone : 053-893 870

Contact : F. Van Oostrum, Coordinator.

General Information :

Wind energy work began in 1971. WOT is operating on the principles of Appropriate Technology. WOT is a sub committee of the Committee for International Activities (CICA) and together with 8 similar groups, WOT constitutes the Tool Foundation.

Activities :

1) Wind data collection and evaluation.
2) Research and development,
3) Extension and promotion.
4) Advisory service on the construction of windmills in developing countries (Bangladesh, Bolivia and Sri Lanka (Cretan windmills)); Kenya, Sri Lanka and Indonesia (12 PU 500 type windmills); India (windmill projects).

Netherlands

Funding Source :

Committee for International Activities (CICA) at the Twente University of Technology.

Publications :

Reviews/Survey.

Windmill Installations :

Demonstration unit and actually operating horizontal axis, water pumping windmills.

Personnel :

A small full-time staff.

4. Tool Foundation,
Mauritskade 619,
Amsterdam 1092 AD,
The Netherlands.

Telephone : 020-926892 Telex : 15080 KITNL attn. TOOL

Contact : Guus ud Sande, Coordinator, Technical Enquiries.

Activities in Wind Energy Technology :

Main activities are :
1) Wind data collection and evaluation.
2) Research and development.
3) Production and marketing (very little).
4) Extension/Promotion.
5) Policy Formulation/Programme Evaluation.
6) Financing/supporting.
7) Specialised on water-lifting by wind energy.
8) Advisory service.

Publications :

Periodicals, publications list. Together with SWD (Steering Committee Wind Energy Developing Countries). Tool Foundation publishes 'Wind and Sun Compendium' completely devoted to the pumping of water with solar and wind energy.

Netherlands

Funding Source :

Minister for Development Cooperation; from universities and individuals in the Netherlands.

Windmill Installation Details

Type of installation :	Actual use.
Type of windmill :	Horizontal axis.
Applications :	Water pumping.

5. Vereniging De Hollands Molen,
Werkgroep Windenergie,
Secr. Platanenlaan 30,
2061 TT Bloemendaal,
The Netherlands.

Telephone : 023-257-373

Contact : H. Wolzak, Secretary.

Activities :

Wind energy activities began in 1973.
Mainly engaged in disseminating information about wind energy.

Funding Source :

From the retribution for the information given.

Publications :

Books, monographs, technical reports, research papers. ('Windmill De Traanroeier Oudeschild' (Texel), technical description of the horizontal axis windmill for the island with capacity of 50 kw is available).

NEW ZEALAND

Renewable resource alternatives, wind generated electricity appears to offer a worthwhile contribution in the short term. New Zealand is situated in a strong wind belt and has a wind power potential ranked amongst the highest in the world.

The total resource is estimated as equivalent to 25,000-100,000 GWh, depending on land use in areas having wind-speed exceeding 7 m/s. A 65 m diameter machine rated at 1 MW would give an output of approximately 4.5×10^6 KWh/yr at a site with an annual mean windspeed of 7 m/s. It is estimated that there are sufficient such sites in New Zealand to accommodate at least 5000 machines. However, the inadequacy of experience with the commercial availability of suitable machines would make large scale implementation before 1985 difficult, though a number of demonstration pilot schemes are planned.

The Meteorological Office is monitoring wind velocities but environmental/visual factors must also be assessed. Even 450 of the machines mentioned above could generate upto 10% of the present annual electricity needs.

New Zealand contains many potentially attractive wind power sites and yet in mainly such areas of complex terrain there are "meteorological data" deserts. One such area is the Rakaia River Gorge region on the eastern slope of the Southern Alps in New Zealand. Local farmers and fishermen speak of incredible winds in the gorge canyon. Hence a survey programme was proposed to utilize laboratory simulation of the relevant wind characteristics in a meteorological wind tunnel. To evaluate the validity of lab simulation methods and provide a confidence measurement bound for laboratory data, a simultaneous limited field measurement programme was organized.

1. Lincoln College,
Dept. of Agricultural Engg.,
Canteburry,
New Zealand.

Contact : G. T. Ward.

New Zealand

Activities :

1) Wind data collection and analysis.
2) Research and development.

Personnel :

G.R. Ward, N.J. Cherry, and R.E. Chilcott.

2. Ministry of Transport,
Meteorological Service,
P.O. Box 722, Wellington,
New Zealand.

Contact : J. Hickman.

Activities :

1) Wind data collection and evaluation.
2) Research and development.

3. Ministry of Works and Development,
Electricity Div.,
P.O. Box 12-041, Wellington,
New Zealand.

Contact : O.T. Jones.

Activities :

1) Wind data collection and analysis.
2) Research and development : The Ministry has installed a wind-powered generator on the Chatham Islands. It also made arrangements for installation of small electricity grid based on diesel powered sets which will provide power for government owned houses, the hospital and various other facilities.

Windmill Installations :

Horizontal axis windmill for power generation.

New Zealand

4. University of Auckland,
Dept. of Mechanical Engg.,
Private Bag, Auckland,
New Zealand

Contact : Prof. V.A.L. Chasteau.

Activities :

1) Wind data collection and evaluation.
2) Research and development : Darrieus-windmill.

Publications :

Research papers.

Windmill Installations :

Demonstration model and functioning vertical axis windmill for power generation (charging storage batteries).

Personnel :

Prof. V.A.L. Chasteau and R.F. Meyer.

5. University of Canterbury,
Dept. of Mechanical Engg.,
Private Bag, Christchurch,
New Zealand.

Contact : A.J. Bower.

Activities :

1) Wind data collection and analysis.
2) Research and development.

Personnel :

A.J. Bower, R.G.J. Flay, A.J.G. Papesch, J.K. Rasne and D. Lindley.

NIGERIA

Very little work has been done in this line, although some simple easy-to-build windmills have been designed and tested. In one design, a Savonius Rotor Windmill was made up of two 44-gallon petrol drums and was coupled to a locally-made diaphragm pump. The unit worked well and was able to pump water effectively. Another design built and tested was a vertical axis turbine-type rotor with sheet-steel blades. This unit gave better results than the Savonius rotor unit.

The Northern areas of Nigeria are among the more windy areas and hence, being rather remote, could benefit from the introduction of these windmills. It is noted that the propeller-type windmills have been in use as pump prime-movers in some coastal towns of Nigeria for years and are still functioning.

The Federal Ministry of Mines and Power has been charged with the development of the new sources of energy. Various bodies, particularly universities have been carrying out basic R&D work on some aspects of wind and solar energy. Financial support has been rather small and results have been rather modest.

PAKISTAN

Wind power as an alternate source of energy is being introduced in the country after the successful installation of a few windmills for water lifting at various places along the coastal areas of Sind and Baluchistan provinces.

The Energy Resource Development (E.R.D.) of Pakistan's Ministry of Petroleum and Natural Resources with the United Nations Development Program granted for 4 additional energy centers in Pakistan at an estimated cost of $1.8 m. An integrated system of shore wind, biogas and solar energy will be developed and power will be combined in a small energy bank to meet the requirements of lighting, irrigation and small agricultural units such as flour mills. The E.R.D. is also in process of establishing 16 rural energy centers using wind, biogas, solar and geothermal energy.

On request of the Appropriate Technology Development, Mr. M. Futehally in Karachi started to repair 6 existing Australian water pumping windmills a few years ago. After their successful installation on farm 6 extra 3.6 m windmills were built, simply by copying the Australian designs. Also a 7 6 m Southern Cross was copied. After visits of SWD (Steering Committee on Wind Energy Developing Countries) advisors, Mr. Futehally became interested in building the 8 bladed, 3 m rotor windmill, developed by the Wind Energy Unit in Sri Lanka. The windmill was erected in 1978 (in windspeeds of 6 m/s the output was 50 litres/minute).

Thus Mr. Futehally of Merin Ltd., Karachi, who are the main fabricators of windmills in Pakistan, have entered in collaboration with ITDG in the joint venture for the development of a low-cost windmill with greater efficiency.

SENEGAL

1. Ecole Polytechnique de Thies
B.P. 10, Thies,
Senegal.

Telephone : 51-14-09 Telex : 7758 EPTHIES SG

Contact : Prof. Y. Youssef and Mr. F. Houmaire.
J. Reme Jutras, Directeur des Etudes.

Activities :

Wind energy work began in 1974.
Activities include installation of 6 windmills in the surrounding region, one for power generation and the other for water pumping. In future, plans are to construct a pump for irrigation purpose using a pump developed at Waterloo University (Canada) and a Filippini Windmill.

Budget :

About $5,000 (Canadian) spent on materials.

Funding Source :

Canadian International Development Agency and local funds.

Publications :

'Les Eolinnes A L'Ecole Polytechnique de Thies' 1978 (technical information of windmills installed).

Windmill Installations :

Horizontal Axis Windmills : 1 Dunlite and 2 Lubing.
Vertical Axis Windmill : 1 locally fabricated Savonius windmill with assistance from Canada.

SINGAPORE

1. University of Singapore,
   Clemente Road,
   Singapore 0511.

   Telephone : 775 6666   Telegram : 'UNISPORE'

   Contact : Dr. G.K. Nathan, Senior Lecturer.

   Activities :

   Work commenced in 1973.
   Specific activities are wind measurement (collection and analysis) and study of wind characteristics.

   Funding Source :

   Engineering Faculty Fund.

   Publications :

   Research papers (1. A Statistical Methodology for Study of Wind Characteristics from a Close Array of Stations (1979). 2. A Study on the Use of Windmills in Singapore, 1976).

   Windmill Installations :

   Laboratory scale horizontal axis windmill.

   Personnel :

   Dr. G.K. Nathan, and Dr. T.N. Goh.

SRI LANKA

The Wind Energy Utilization Programme of the Sri Lanka Government started in 1977, with assistance from the Government of Netherlands. In the past two and half years the Wind Energy Unit (WEU) of the Water Resource Board, responsible for the implementation of the programs has developed two prototypes of windmill water pump system (WEU I/2 3 m diameter and WEU II/2 5 m diameter). At the same time, a strong organization has been built up and windmill know-how has been transferred from Holland to Sri Lanka.

A seperate section has been formed within the Wind Energy Unit (WEU), for pilot project study. A research proposal has been prepared to outline the general set-up of the studies at the pilot projects. The period of the study covers 1980 and 1981. In these 2 years, the possible constraints to a successful introduction of windmills to small farmers will be studied, including mechanical, agricultural, water management and socio economic aspects. 15 sites have been selected as pilot project sites.

The Government has decided to make available a sum of Rs. 7, 500/- per windmill WEU I/2 as a capital grant for 110 windmills. In each of the 11 Dry Zone Districts, 10 farmers will be selected through the Government Agent.

The results from the pilot projects, the 110 windmills through the Government and private, will make clear whether there is a sound future for the windmills in Sri Lanka.

The WEU also intends to examine the question of electricity generation with windmills and the attractivity for Sri Lanka or at least for specific areas and purposes.

1. Sarvodaya Shramadana Sangamaya,
   100, Damsakmandira,
   Ramathawalta Rd., Moratuwa,
   Sri Lanka.

   Telephone : 072 - 7159

Sri Lanka

Contact : Mr. Dharmadasa Pathirana.
Mr. Jothi Siriwardhana.

Activities :

Wind energy work began in 1975.
Main activities are :
1) Wind data collection and evaluation.
2) Research and development: Low cost wind pumps.
3) Extension/promotion: Demonstration.
4) Policy formulation/programme evaluation.
5) Financing/supporting.

Funding Source :

Novib, Helvetas.

Windmill Installations :

Demonstration unit and operating horizontal axis water pumping windmill.

2. Water Resource Board,
Wind Energy Unit,
2A, Gregory's Avenue,
Colombo 7,
Sri Lanka

Telephone : 074-2391 Telegram : 'JALASAMPAT'

Contact : K.S. Fernando, Dy.General Manager, WEU.

Activities :

The Wind Energy Utilization Project began in 1977, with assistance from Govt. of Netherlands and involved following activities :
1) Designing and testing of small scale water pumping windmills.
2) Building up of an anemometer network in Sri Lanka.
3) Transfer of technology on wind energy systems in general from Netherlands to Sri Lanka.

The Pilot Project Studies aim at providing necessary data for policy makers, manufacturers and farmers.

Sri Lanka

In general, main activities are :

1) Wind data collection, evaluation and site selection.
2) Development of small scale windmills.
3) Extension/promotion.
4) Policy formulation/programme evaluation.

Publications :

Programme summaries and reports ('Wind Energy Utilization in Sri Lanka, Sept. 1979-Dec. 1979').

Budget :

Rs. 6,000,000 per annum.

Funding Source :

Steering Committee for Wind Energy in Developing Countries, Netherlands and Govt. of Sri Lanka.

Windmill Installations :

Horizontal axis water pumping windmills.
Models WEU I/2 : 3 m rotor diameter.
WEU II/2 : 5 m rotor diameter.

Personnel :

6 Engineers, 3 Agricultural Officers and others.
Workshop consists of 5 mechanics and 8 labourers.

SWEDEN

In 1975, the National Swedish Board for Energy Source Development (NE - Namnden for Energiproduktionsforskning) was set up to establish, support and evaluate research and development into new energy sources. NE has taken over the responsibility for the Wind Energy Program which was initiated in 1973 by the National Swedish Board for Technical Development (STU) and to some extent, by the Swedish State Power Board (Vattenfall).

Sweden is situated within a belt of strong westerly winds. The windiest area, amounting to a total of 12,000 sq. km, are characterised by medium windspeeds of at least 7 m/s at 100 m above ground. A detailed siting analysis found that part of this high wind region could accommodate about 11,120 wind generator with blade diameter 50 m, which would generate a total of about 20 TWh during a normal year. Current thinking favours a smaller number (3,300) of large units (100 m diameter) which would produce a large quantity of energy, 32 TWh/year.

In 1974, the Swedish State Power Board estimated that up to 12.5 TWh/year of wind generated electrical energy (corresponding to 5 GW rated power) could be accommodated within the existing electricity grid system. It is predicted that by 1990 the Wind Energy Conversion System installations visualised would be capable of providing approximately 10% of the national demand.

Over the period 1975-78, the Swedish government has spent 20 m SKr ($4 m) on wind power. This has provided for wind energy prospecting, wind generator design study, systems analysis and the construction of an experimental unit, the 63 kw rated wind generator built by Saab-Scania at Alvkarleby.

Over the three years starting with fiscal 1978/79, the Swedish government is providing 105 m SKr ($21 m) for wind power. Part of this will cover the design and construction of two or three prototype units, each rated in the 1-2 MW range.

Of the 5000 km^2 of offshore area of less than 30 m water depth around Sweden's Coastline, 3300 km^2 line is in good wind energy area. In addition, the position of a wind turbine off-shore can increase its specific energy output by 40% and its environmental impact could be reduced. Present day study seeks to

exploit with design for horizontal and vertical axis turbines of 7 to 14 MW which could be constructed in commercial shipyards and towed to their locations, study by SIKOM AB and FFA, The Aeronautical Research Institute of Sweden.

1. * Allamanna Ingenjorsbyran Ab,
Box 5511,
S 11485 Stockholm,
Sweden.

Contact : S. Andersson, B. Pettersson.

Activities :

Creation of program for computerized analysis of dynamical problems in systems for blade control in Wind Energy Conversion Systems.

Funding Source :

Namnden for Energiproduktionforskning, Sweden.

2. * ANASYN Ab,
Kistavagen 4, S-191 70,
Sollentuna,
Sweden.

Contact : I.A. Lind.

Activities :

Project titled - Gains in wind turbine performance due to rotor airfoil improvement was undertaken in 1978.

Funding Source :

Namnden for Energiproduktionforskning, Sweden.

Sweden

3. * Chalmers Tekniska Hogskola,
S 40220 Goteborg 5,
Sweden.

Contacts : S. Vonzweygbergk, Electrical Machinery.

Activities :

Testing of small wind power units.

Funding Source :

Namnden for Energiproduktionforskning, Sweden.

4. FFA, The Aeronautical Research Institute of Sweden,
Box 11021,
S 16111 Bromma,
Sweden.
Telephone : 08 262840 Telegram : 'Flygtekniska'
Telex : 10725

Contact : A. Gustafsson, FFA Wind, Energy Coordinator.

Activities :

Wind energy work began in 1975.
Activities include :

1) Technical assistance to Swedish Board for Energy Source Development (NE).
2) Safety analysis of wind turbine systems.
3) Analysis of wind turbine-blades.
4) Study of guyed wind turbine.
5) Theoretical and experimental investigations of Wind Energy Conversion Systems.
6) Testing Kalgugnen Wind Plant (Blade,design, instrumentation, lab tests).
7) Development of prototypes Skane-Gotland.
8) Alternative concept study : Vertical axis turbine and other specific solutions like L-turbine, DB-double blades.

Sweden

Budget :

$1 m per annum.

Funding Source :

NE - National Swedish Board for Energy Source Development.

Publications :

Several technical reports on various topics of wind energy and on the above activities. List of FFA wind energy reports published under contract with NE is also available.

5. * Karlsisrona Varvet AB,
Box 1008, S-371 24, Karlskrona,
Sweden.

Telephone : 46455 194 40

Telegram : Karlskronavaru
Telex : 43056 KKRVS
Karlskrona

Activities :

Karlskronavaruet AB, a subsidiary of the Swedyards Corp., is now building two MV-size wind power plants, one of which has been ordered by National Swedish Board for Energy Source Devl. and the other by the U.S. Dept. of the Interior. The plants are located in Trelleborg (Sweden) and Medicine Bow (Wyoming, U.S.A.).

Publications :

Program summaries/project reports, brochures.

Windmill Specifications : (Electricity generating windmill)

Turbine Type : Horizontal axis

MODEL	WTS 3	WTS 4
Rotor diameter	78 mt	78 mt
No. of blades	2	2
Blade material	Epoxy plastic reinforced with fibre glass	

Sweden

MODEL	WTS 3	WTS 4
Transmission	Gear	Gear
Transmission ratio	1:60	1:60
Governing	blade pitch control system	
Maximum output	3MW at 1500 rpm	4 MW at 1800 rpm
Tower Material	Steel	Steel

6. * Lutab Ingenjorsbyran AB,
Snormakarvagen 29,
S 16 147 Bromma,
Sweden.

Contacts : I. Carlsson; S. Luthander.

Activities :

1) Coordination of the research and testing program conducted at the Kalkugnen Wind Power Plant.
2) Advisory service on small wind energy conversion systems to firms or individuals.
3) Supplying technical specification for design of small wind turbine systems.
4) Using wind energy for heat generation.

Funding Source :

Namnden for Energiproduktionforskning.

7. * Mellby Industri AB,
S-460 30,
Sollebrunn,
Sweden.

Contact : G. Ulfvengren.

Sweden

Activities :

Measurement of performance on the Mellby Wind Turbine, built in 1977 (a vertical axis machine with straight rocking blades). Project undertaken in 1978.

Funding Source :

Namnden for Energieproduktionforskning.

8. * Praktisk Teknik Ab,
Skoldmyrvagen 1,
S 72231 Vasteras,
Sweden.

Contact : R. Andersson, H. Ingvast.

Activities :

Study of guyed and un-guyed towers in framework design for wind power stations with horizontal axis.

Funding Source :

Namnden for Energiproduktionforskning, Sweden.

9. * Saab Scania AG,
Linkoping,
Sweden.

Contacts : A. Fischer, Aerospace Div.
B. Lindkvist, Aerospace Div.
G. Gustavsson, Aerospace Div.

Activities :

1) Development of coal fibre reinforced turbine blades for the Kalkugnen Wind Power Test Plant.
2) Conducting measurements at the Kalkugnen Wind Power Test Plant.
3) Assistance to the Swedish State Power Board operators for maintainance (repairs, modifications, instructions) of the Kalkugnen Wind Power Plant.

Sweden

4) Analysis of test results at the Kalkugnen Wind Power Test Plant.

Funding Source :

Namnden for Energiproduktionforskning.

10. * SIKOB Ab,
S 19178, Sollentuna,
Sweden.

Contact : R. Hardell, Engineering Center.
C. Olsson.

Activities :

1) Project entitled - methods for effecting torque limitation in wind turbine gears - was undertaken in 1978.
2) Research and development of offshore wind energy systems.

Funding Source :

Namnden for Energiproduktionforskning, Sweden.

11. Swedish Maritime Research Centre,
Box 24001, S-400 22,
Goteborg,
Sweden.

Telephone : 031/200130 Telegram :'SKEPPSPROV Goteborg Sweden'
Telex : 20863

Contact : Dr. H. Edstrand.

Activities :

Wind energy work commenced in 1977.
Specific activities are :
1) Research and development of stationary horizontal axis windmill.

Sweden

2) Literature survey (shipborad applications).

Publications :

Reviews.

Funding Source :

Transportforskningsdelegationen, Stockholm.

Windmill Installations :

Horizontal axis windmills for power generation.

Personnel :

C.A. Johnsson (land based power stations); L. Larsson; H. Liljenberg (ship application).

12. * Swedish Meteorological & Hydrological Institute,
S 60101 Norrkoping,
Sweden.

Contacts : L. Rannalect; L.E. Olsson, Climate Branch.

Activities :

1) Wind forecasting for wind power plants.
2) Collecting windspeed data at heights relevant for wind power utilization.

Funding Source :

Namnden for Energiproduktionforskning, Sweden.

13. * Swedish University of Agricultural Sciences,
Faculty of Agriculture,
S-23053,
Alnarp,
Sweden.

Contacts : E. Skarback, Landscape Planning.
C. Sellberg.
B. Schibbye.
K. Nilsson.

Sweden

Activities :

A project - Principles of adapting single wind power aggregates and group stations in the landscape - was undertaken in 1977.

Funding Source :

Namnden for Energiproduktionforskning, Sweden.

14. * Teleplan Ab,
S 17120 Solna,
Sweden.

Contacts : P. Johansson.
S. Leijonhufvud.
S. Lundgren, Aeronautical Research Inst.
R. Hardell, Svenska Institutet for Konserverings-forskning.

Activities :

1) Planning and coordination of the testing of Kalkugnen Wind Turbine Station (63 kw test unit).
2) Administers and coordinates projects belonging to the subprogram "Prototypes" of the "wind energy" programme.

Funding Source :

Namnden for Energiproduktionforskning, Sweden.

15. V.B.B.,
Geijersgatan 8,
S-216, 18, Malmo,
Sweden.

Telephone : 040-15 90 00 Telegram : 'VATTEN Malmo'
Telex : 32641 Vatten S

Contact : Erik Skarback, Landscape Architect.

Activities :

Wind energy work commenced in 1979.
Main activity is research and development.

Sweden

Funding Source :

Energy production companies.

Windmill Installations :

Demonstration unit, horizontal axis windmill for power generation.

TANZANIA

The institutions working on windmill programme in Tanzania are mainly the Ministry for Water, Power and Minerals (MAJI) with its workshops in Dar-Es-Salaam, Dodoma, Arusha, Shinyanga, Singida, etc., the University of Dar-Es-Salaam with its Faculty of Agriculture in Morogovo and the Faculty of Engineering in Dar-Es-Salaam, and institutions like Appropriate Technology Development Unit in Arusha, or TAMTU (Tanganyika Agricultural Machinery Testing Unit) also in Arusha. The Tanzania National Scientific Research Council, through its Solar Energy Promotion Committee tries to gather information on all ongoing projects in Tanzania and promote new projects.

Experience with conventional windmills for water pumping indicate strong and consistant winds during most time of the year in several regions in Tanzania. Most of the present windmills are for water pumping and imported. One of the design sponsored by MAJI is the so called Arusha Windmill (also known as VITA - Tanzania type) around 10 of them were built during the last 2 years. The MAJI windmill programme, according to a statement of the Minister of Water, Power and Mineral included also the installation of 130 windmills and pumps in a three year project assisted by Australia. In Manyani district, seven windmills of 5 m diameter and of Italian make were installed. Three Dutch students built a windmill for domestic water supply in village Kiguru-Kiro. Local efforts are also reported from Musoma area and from a Naivoli village.

Several very specific projects, both for water pumping windmills and for wind-driven generators are proposed, the most important one being a village power station of 45 kw based on wind power.

1. Arusha Appropriate Technology Project,
   P.O. Box 764,
   Arusha,
   Tanzania.
   Telephone : 3594 Telegram : 'ATARU' Telex : 42126

   Contact : Wayne Nishek, Technical Coordinator.

Tanzania

Activities :

Work began in 1978.
Main activities have been as under :
1) Two years ago AATR assisted Ujuzi Leo in the construction of a windmill.
2) Built and installed approximately 15 windmills throughout Tanzania.
3) Currently re-designing a new 8 bladed windmill. Efforts are being made towards building windmills using locally available materials to produce electricity in rural areas.

Funding Source :

Small Industries Development Organization;
Swedish International Development Aid.

Publications :

Windmill Manual to be published soon.

Windmill Installations :

1 Savonius (vertical axis) Windmill for water pumping and 15 horizontal axis windmills for water pumping.

Personnel :

Dick Stanley, Walfgang Wasserthal and Fredrick Sumaye.

THAILAND

1. Asian Institute of Technology,
P.O. Box 2754,
Bangkok,
Thailand.

Telephone : 5168 3115 Telegram : 'AIT BANGKOK'

Contact : Dr. R.H.B. Exell.

Activities :

Wind data analysis.

Publication :

'Available Wind Energy in Thailand' by Mr. S. Thavapalachandran (M.S. Thesis, 1980).

Windmill Installations :

Demonstration unit, horizontal axis windmill for power generation.

2. National Energy Administration,
Pibultham Villa,
Kasatsuk Bridge,
Bangkok 5,
Thailand.

Telephone : 2230021 Telegram : 'NATPOWER'

Contact : Mr. Phol Songpongs : Director, Project Manager, USAID-Thai Non Conventional Renewal Energy Project.
Mr. Sompongse Chantavorapap : Alternative Energy Study and Development Project.
Mr. Pairaj Voravej : Chief, Wind Energy Unit.

Activities :

1) Resource assessment.
2) Need assessment.
3) Popularization of wind energy.

Thailand

4) Development and demonstration of windmills.
5) Promotion/extension.

Publications :

Reports.

Funding Source :

Royal Thai Government and USAID and Thai Government Non-Conventional Renewable Energy Project.

Windmill Installations :

Demonstration units, horizontal axis water pumping windmill.

Personnel :

12 technical staff.

TURKEY

In almost 10-20% of the settlement centres of Turkey, the possibility of making use of the wind power exists. The utilization of wind power was not seriously investigated until recently. Although the importance of the wind power in the electricity generation was not fully recognized, still in some settlement centres it is used, though very primitively.

Large scale utilization of wind power under circumstances prevailing in Turkey cannot be considered economic as the country's potential in this respect is relatively small. Seasonal winds, velocities highly variable, are recarded in the country, but the wind period per hour is very low. Plans, are made to utilize this energy source in the rural areas.

Wind-operated machines may be successfully employed in the operation of water pumps and direct current generators used in the generation of electricity. Although several types, may be used to this effect, those operating at less than KW power are considered feasible and economic particularly for the agricultural purposes. Although very limited in use, examples of this type of application can be found in some settlement centres, being mainly employed in the water wells. Plans are made to increase the number of the developed and improved wind-operated power machines and to use these throughout the country.

U.K.

Wind energy research has attracted some interest from the electricity authorities as it has been suggested that wind generators could provide some 20% of Britain's requirements as firm power and in 1979-80, £450,000 was to be spent on wind energy research.

Investigations have shown that the western seaboard and the islands of the British Isles were capable of supplying wind-generated electrical plants with both available and consistent winds.

The overall aim of the U.K.'s R&D programme is to establish the feasibility of both land and offshore sited aero-generators. The U.K. collaborative program, founded by the Department of Energy and supervised by the Central Electricity Research Laboratories, five different designs of wind turbine of sikilar size are to be built by different groups.

Of the two horizontal-axis wind turbines, one is a 17 m diameter fixed-pitch machine built as a private venture by Sir Henry Lawson Tancred & Co. The other HAWT is a variable pitch machine of 5 m diameter designed and built by Sussex University College. It is installed on Rhossili Down, one of the windiest regions of Britain.

Three vertical-axis wind turbines (VAWT) are to be tested. Newcastle University Energy Centre with Kingston Polytechnic are building a conventional 5 m diameter 5 kw Darrius 'egg beater'. Exter University Wind Power Unit is developing a 5 m diameter machine with vertical blades and cyclically-variable pitch controlled by a wind vane so that blade angle-of-attack is optimized with respect to direction. The third VAWT is a Musgrove type developed by P.I. Specialist Engineers Ltd.

In parallel with the official research, many independent centres are equally active. Low Energy Systems in Dublin has developed an interesting vertical axis machine of extreme simplicity. A simple and efficient low-cost horizontal axis windmill has been designed for easy contruction in Third World countries by the Intermediate Technology Development Group together with the Energy

U.K.

Group of Reading University. For purely electrical applications, a permanent magnet alternator has been designed and built at Imperial College, London.

Operational experience on five types of wind machine, ranging from a multiblade 'Southern Cross' type pumping mill to an Elektro 5 kw horizontal machine and a DAF 3.2 kw vertical axis turbine, is being gained by the National Centre for Alternative Technology at Machynlette in Wales.

There are only some of the projects in progress, for wind energy research in the U.K. Interest, already strong, is increasing and it should not be long before a wide range of useful hardware is on the market.

1. Central Electricity Generating Board,
Planning Dept.,
20, Newgate St.,
London EC1,
U.K.

Telephone : 248-1202 Telegram : 'MEGAWATT LONDON EC1'
Tele[illegible] · 883141

Contact : A.P. Rockingham, Hydro & New Energy Source Section.

Activities :

First phase in wind energy lasted from 1950 to 1966. Second phase commenced in 1975. Main activities are :

1) Collection of wind data on and off-shore at low and high altitude using masts and towers.
2) Research using wind tunnel experiments and scale models.
3) Field measurement of wind regime characteristics carried out on the 17 m diameter, 30 kw, horizontal axis wind generator at Aldborough.

Funding Source :

Internal.

Publications :

Research papers.

U.K.

Personnel :

About 10 men per year (increasing).

2. ERA Technology Ltd.,
Cleeve Road, Leatherhead,
Surrey KT22 7SA,
U.K.

Telephone : 03723 74151 Telex : 264045

Contact : Mr. B. Boss.

Activities :

Wind energy work commenced in 1948 and ERA is currently one of the largest independent research organizations of U.K. Several activities :

1) Site surveys conducted for over 100 hill sites in Great Britain and Ireland.
2) Economic and feasibility studies of using machines on island sites and studies of the export potential for large and small WTG's.
3) Designing and developing wind measuring instruments (developed the gust anemometer).
4) Development of three 100 kw machines. Designing of 60 m diameter, 3.7 MW WTG.
5) Advisory service : To the industrial group in U.K. and overseas utilities on wind power site selection.

Budget :

£5 M

3. Intermediate Technology Development Group Ltd. (ITDG),
9, King Street,
London WC2E 8HN,
U.K.

Telephone : 01 836-9434 Telegram : 'IT DEV LONDON WC20'

Contact : Peter L. Fraenkel, Power Project Officer.

U.K.

Activities :

1) Development of wind pumps (begun in 1975) suitable for small scale economic manufactures.
2) Advisory Service : An ITDG subsidiary, Intermediate Technology Consultants Ltd., assists governments and other agencies on the utilization of intermediate technologies in their development plan.
3) Testing prototype windmills in Botswana, Kenya, Egypt, Oman, Pakistan, Sri Lanka, Zambia and Antiqua.
4) Currently supporting a private enterpreneur with a design of a small wind powered battery charger (50 W).

Publications :

Variety of publications : Guides, bibliographies, specification of tools and equipments, manuals, special reports on field operations, industry profiles and a quarterly journal "Appropriate Technology."

Budget :

£10,000-£20,000 per annum.

Funding Source :

Christian Aid and Overseas Development Administration.

Windmill Installations :

Demonstration and actually functioning horizontal axis windmills for pumping water and power generation.

Low Energy System,
3, Larkfield Gardens,
Dublin 6,
Ireland.
Telephone : 01-96-0653

Contact : Brian Hurley, Director.

U.K.

Activities :

Work commenced in 1973.
Main activities are :
1) Wind data collection and evaluation.
2) Research and development : Successfully developed wind electric fence, vertical axis sail windmill (200 W output) and a trickle charger wind generator (for light bulb or a radio, 6V/12V system, 3-5 W output). Currently engaged in wind power site analysis and wind system design.
3) Production and marketing.
4) Extension/promotion.
5) Policy formulation/programme evaluation.

Funding Source :

Private/Government.

Publications :

Books and monographs.

Windmill Installations :

Type of installation : Laboratory scale, demonstration models and actual use type.
Type of windmill : Vertical axis and horizontal axis.
Applications : Power generation and water pumpi

5. National Centre for Alternative Technology,
Llwyngwern Quarry,
Machynlleth Powys,
Wales.

Telephone : Machynlleth 2400.

Contact : Dr. Robert Todd.

Activities :

Wind energy work commenced in 1976.
Main activities :
1) Demonstration of different wind machines (continuous monitoring programme).

U.K.

2) Future plans to include large electricity generating machines (30-60 ft diameter) and demonstration of new machines as they are brought out.

Budget :

£100,000 spent on wind energy programme.

Funding Source :

Occasional small donations and from gate admissions (charity).

Publications :

Do-it yourself plans (pumping and sail windmills), information sheets, technical reports (windmills at the Centre), visitors guide to the site and exhibits, resource sheets.

Windmill Installations :

Vertical Axis Windmills : DAF 3 kw in use for power generation.
Savonius - demonstration.

Horizontal Axis Windmills : (a) In use for power generation

Mullins - wind pumps
Cretan - D14
Electro - 5 kw
Winco - 200 kw
Dunlite - 2 kw

(b) Demonstration

Climax - wind pump
Sparko - wind pump
PIY - bicycle wheel

Personnel :

Dr. Robert Todd, Andrew P. Brown, Guy Watson and Roger White.

U.K.

6. University of Ulster,
Coleraine,
North Ireland.

Telephone : 0265-4141 Telegram : 'UNIVERSITY COLERAINE'

Contact : Dr. J.T. McMullan, Sr. Lecturer in Physics.

Activities :

Work initiated in 1975.
Specific activities :
1) Wind data collection and evaluation.
2) Policy formulation/programme evaluation.

Funding Source :

Internal.

Publications :

Research papers.

Personnel :

Mr. K. Wilson and Dr. R. Morgan.

7. Queens University of Belfast,
Dept. of Engg. Mathematics,
Belfast BT95AH,
North Ireland.

Telephone : 66111

Contact : Dr. D. Sprevak, Lecturer.

Activities :

Wind energy work commenced in 1979.
Main activities :
1) Wind data collection and evaluation.
2) Wind research.

Funding Source :

Queen's University.

U.K.

Publications :

Research papers ('A Comment on Fitting Stochastic Models to Wind Data' (1979); 'The Probability Distribution of Wind Velocity and Direction' (1979)).

Personnel :

Dr. D. Sprevak and Mr. B. McWilliam.

8. Trinity College,
Statistics & Operations Research Lab.,
Dublin 2,
Ireland.

Telephone : 772941   Telex : 31166 TCD EI

Contact : Prof. F.G. Foster.
T. Gibbons, Manager of Lab.

Activities :

1) Systems analysis particularly with respect to integration into electricity network.
2) Future plans to conduct time series analysis of meteorological data obtained from dispersed sites.

Budget :

£10,000 per annum.

Funding Source :

Irish Government; National Board for Science and Technology.

Publications :

2 technical reports and 3 research papers.

Personnel :

1 full time, 2 part time.

U.K.

9. University College,
Dept. of Mechanical Engg.,
Torrington Place,
London WC1E 7IE,
U.K.

Telephone : 01-387-7050

Contact : Dr. B.R. Clayton, Lecturer.

Activities :

Work commenced in 1975.
Primary research programme includes :
1) Study of wake shedding from models in an open jet wind tunnel.
2) Wake interaction of clusters of turbines.
3) Scale effect on performance.
4) Flow utilization studies around Darrieus and Savonius rotors.

Budget :

£10,000 for 1979-1981.

Funding Source :

Science Research Council.

Publications :

Research papers.

Windmill Installations :

Laboratory scale and demonstration models of horizontal and vertical axis windmills for power generation applications.

Personnel :

P.Filby, B.R. Clayton.

U.K.

10. University of Exter,
Chemical Engg..
EX4 H0J,
U.K.

Activities :

Working on simple, low cost vertical axis wind turbine since 1975.

Publications :

Technical reports and research papers ('Wind Energy Project (May 1977)'; ' A Theoretical and Experimental Investigation into the Variable Pitch Vertical Axis Wind Turbine (1978)').

11. University of Reading,
Dept. of Engg.,
Energy Group, White Knight,
Reading RG6 2AY,
U.K.

Telephone : 851321

Contact : Prof. P.D. Dunn, Head of the Group.

Activities :

Wind energy work commenced in 1975.
Two separate programmes are underway :
1) The 'Large System Study' looking at wind power integration into the national grid.
2) The 'Small (isolated) Systems Study' looking at stand alone systems in the 10 kw to 1 mw range (examples Scottish Island communities or isolated (non-grid) situations anywhere in the world.

Publications :

University of Reading programme summary; several papers and reports on wind power integration studies.

Personnel :

Staff of 30 senior staff comprises of Prof. N.H. Lipman, Dr. P.J. Musgrove and Dr. G. Rice.

U.S.A.

1. **The Aerospace Corporation,**
Energy & Resource Div.,
2350 E. El Segundo Blvd.,
El Segundo, CA. 91556,
U.S.A.

Telephone : 213-648-6154

Contact : Leon R. Bush, Wind Energy Conversion Systems
Project Manager.

Activities :

Work commenced in 1975.

1) Research and development : Performed several application studies which explore the economic, technical and operational issues in the practical application of large wind Turbine Generators (WTGs) to electrical utilities.
2) Wind data evaluation.
3) Policy formulation/programme evaluation.

Publications :

Programme summaries, project evaluation reports, technical reports.

Budget :

Variable.

Funding Source :

State and Federal Agencies.

Windmill Installations :

Studies are conducted on hypothetical horizontal axis windmills for applications like power generation

U.S.A.

2. * Aerovironment, Inc.,
145, Vista Avenue,
Pasadena, CA. 91107,
U.S.A.

Contact : Stel N. Walker, Peter Lissaman.

Activities :

1) Identify cost effective measurement systems for wind energy conversion sites.
2) Provide technical evaluation and economic assessment of augmented horizontal axis wind energy systems and high lift wind energy systems.
3) Determine performance and cost effectiveness of tip vane power augmentation.

Lead Agencies :

Pacific Northwest Laboratory, Richland; Solar Energy Research Institute, Colorado.

Funding Source :

U.S. DOE.

Publications :

Technical reports.

3. Alternative Energy Institute (AEI),
West Texas State University,
P.O. Box 248, Canyon, Texas 79016,
U.S.A.

Telephone : (806)-656-3904

Contact : Dr. Vaughn Nelson, Director.

Activities :

AEI was created in 1977 by W.Texas State University. Activities are as under :
1) Data collection and evaluation.
2) Testing of wind energy conversion systems.
3) Teaching and training: 2 new courses offered for the University (a) Residence and Rural Systems, and (b) Wind Energy and Wind Turbines.

4) Collection and distribution of information : AEI maintains an information center with materials on wind energy resource and commercially available wind energy. Collection includes reports from NASA, Sandia, Battelle PNL, NTIS and DOE.

Publications :

Several technical reports and research papers on various topics of wind energy.

Budget :

$120,000 per annum.

Funding Source : State of Texas.

Windmill Installations :

Currently testing 2 Vertical Axis Wind Turbine (DAF 4, DAF 40) and 3 Horizontal Axis Wind Turbine (Dakota, Winger, Carter) for applications like water pumping and power generation.

4. Alternate Energy Systems, Inc.,
614 S. Cleveland St.,
Oceanside, CA. 92054,
U.S.A.

Telephone : 1-714-722-5010

Contacts : William A. Lutes, Chairman.
Fredrick J. Carroll, Vice President.

Activities :

Wind energy activities began in 1978.
1) Wind data collection and evaluation.
2) Production and marketing.
3) Extension/promotion.
4) Financing/supporting.

U.S.A.

Funding Sources :

Private/commercial.

Windmill Installations :

Type of installation : Actual use.
Type of windmill : Vertical axis and horizontal axis.
Application : Water pumping and power generation.

Additional Information :

William A. Lutes of the Alternate Energy Systems, Inc., has set up Wind Energy Unlimited, a cash-and-carry dealership for electricity generating windmills in San Diego Oceanside. Lute's dealership stocks 4 windmill models priced from $600 to more than $6,000 used for charging battery and pumping water from depth of 300 feet.

5. Alternative Sources of Energy, Inc., (ASE),
107, S. Central Ave.,
Milaca, MN. 56353,
U.S.A.

Telephone : 612 (983) - 68 92

Contact : Donald Marier, Editor.

Activities :

Wind energy work commenced in 1971.
Main activities are :
1) Extension/promotion.
2) Wind information : Maintains a library of 1,000 books, articles and journals. Offers bibliographic and information searches, as well as consulting services through its Energy Information and Referral Services.

Publications :

Publishes "Alternative Sources of Energy" (bi-monthly magazine) and "Energy Digest" (midwest newsletter).

U.S.A.

6 American Wind Energy Association (AWEA),
1609, Connecticut Ave., N.W.
Washington D.C. 20009,
U.S.A.

Telephone : (202) 667-9137

Contact : Mr. Benjamin Wolff, Executive Director.

Activities :

Main activity is publishing. Publishes information on research contracts, news releases, conference proceedings, and items of general interest. Sponsors two conferences each year which include presentations and exhibits. Provides Federal and State legislators with necessary information to make a reasonable assessment of wind as an energy source. AWEA brochure, contains membership and organizational information. It also contains information on the use of wind energy, siting, the economics of wind energy, wind energy publications, commercially available wind machines, wind machine distributors and the Federal Wind Energy Program.

Publications :

Two regular publications, the AWEA Windletter and the Wind Technology Journal.

Budget :

$250,000 per annum.

7. Aluminium Company of America,
Alcoa Laboratories,
Alcoa Center, PA, 15069,
U.S.A.

Contact : Marvin Williams,

Activities :

Fabrication of low-cost vertical axis wind turbine.

U.S.A.

Lead Laboratory :

Sandia Laboratories, Albuquerque.

Funding Source :

U.S. Department of Energy (DOE).

8. * The Boeing Engineering and Construction Co.,
P.O. Box 3707,
Seattle, WA. 98124,
U.S.A.

Contact : W.H. Robbins, Jim Couch.

Activities :

MOD-2 Turbine Project : Designing, fabricating and testing three experimental 300 foot diameter wind turbines of the horizontal axis type with capacity 2.5 kw.

Lead Agency :

NASA Lewis Research Center, Cleveland.

Funding Source :

U.S. Department of Energy (DOE).

Cooperative Utility :

Bonneville Power Administration Portland, Oregon.

9. Bonneville Power Administration,
P.O. Box 3621,
Portland, OR. 97208,
U.S.A.
Telephone : 503-234-3361

U.S.A.

Contact : Douglas Seeley (Person-in-charge MOD-2)
Steve Levy (Pilot Project)
Gene Tollefson, Public Information Officer

Activities :

Wind energy activities commenced around the year 1979-80.
Presently, there are 2 major programmes :

1) MOD-2 Turbine Project : Test of three-unit of 2500 kw Boeing MOD-2 wind turbines supplied and installed by the U.S. Department of Energy.
2) Pilot Project : 1) Loan of wind recording instrumentation through public utilities to individuals to assess the wind resource at 140 sites in the Pacific Northwest. 2) Site evaluation followed by erection of 13 small wind energy conversion systems from 1.5 kw to 4 kw at private residence. Homeowner option to purchase after 5 years.

Budget :

MOD-2 Project	-	FY 1981-$180,000.
		FY 1982-$150,000.
Pilot Project	-	$450,000.

Funding Source :

Bonneville Power Administration, self financed through power revenue from utility-customers.

Publications :

Public information booklets on both above programs. Reports will be generated in the beginning of 1981 on MOD-2; small wind energy booklet available 1981.

Windmill Installations :

MOD 2 Turbine : Three 2500 kw, upwind, two bladed, soft steel tube support, synchronous generator, pre-commercial units.
Pilot Project : 2 Enertech Corporation 1.5 kw small wind energy conversion systems.

U.S.A.

Personnel :

MOD 2 : D. Seely, R. Holeman, N. Butler.
Pilot Project : Steve Levy, Roy Reinhart.

10. * The BUDD Co.,
375, Commerce Drive,
Ft. Washington, PA. 19^^
U.S.A.

Contact : W. Eggert.

Activities :

Developing low cost wind turbine blade fabrication methods. This task was initiated in 1978 and will continue till 1982. The efforts include full-scale (MOD-OA) blade design and fabrication phase.

Lead Agency :

NASA Lewis Research Center, Cleveland.

Funding Source :

U.S. Department of Energy (DOE).

11. California Energy Commission,
Wind Energy Programme,
1111 Howe Avenue, MS 66,
Sacramento, California 95825,
U.S.A.
Telephone : (916)-924-2496

Contact : Mr. Robert Thomas.

Activities :

Wind energy work commenced in 1977.
Main activities are :
1) Commercialization of large wind electric conversion systems.
2) Wind resource prospecting.

U.S.A.

3) Site verification.
4) Wind machine demonstration.

Budget :

About $500,000 per annum.

Funding Source :

State of California.

Publications :

Several reports and research papers on wind energy assessment, wind resource potentials of California and its regions. Reports on environmental impact, large WES in California. ('California Wind Directory' (May 1980); 'Personnel and Organizations involved in Wind Energy in California' (Feb. 1980)).

Personnel :

Staff of 11, four of them are student assistants.

12. Clarkson College,
Mechanical & Industrial Engg. Dept.,
Potsdam, N.Y. 13676,
U.S.A.

Telephone : 315-268-2321

Contact : Dr. Edward Kear, Chairman.

Activities :

1) Wind data collection and evaluation.
2) Research and development : Vertical Axis Wind Turbine (VAWT) Project.

Funding Source :

Industrial support.

Windmill Installations :

Demonstration units of horizontal and vertical axis windmills for applications like power generation.

U.S.A.

13. * Colorado State University,
Fort Collins,
CO. 80523,
U.S.A.

Contacts : R. Meroney (Dept. of Civil Engg.)
J.R. Gnnell (Dept. of Mech. Engg.)
Robert N. Meroney
Virgil A. Sandborn

Activities :

1) Wind tunnel model studies for wind power sites. Selecting potential WECS sites in the Kahuku area (Hawaii).
2) Development of wind-powered pump in a dairy operation (a VAWT has been constructed and connected to a milk cooling/water heating system at the Colorado State University dairy farm).
3) Provide methods for measuring and analyzing wind near a WECS for performance evaluation.

Lead Agency/Lab :

Pacific Northwest Lab., 'ichland.
U.S. Dept. of Agriculture, Beltsville.

Funding Source :

U.S. Department of Energy (DOE).

14. * Cornell University,
Agricultural Engg. Dept.,
Ithaca, New York,
U.S.A.

Contact : W.W. Gunkel.

Activities :

1) Direct mechanical conversion to heat : A 12 ft diameter, VAWT is being used to heat water near Ithaca.

U.S.A.

Lead Agency :

U.S. Dept of Agriculture, Beltsville.

Funding Source :

DOE.

15. * Desert Research Institute,
P.O. Box 60220,
Reno, NV. 89506,
U.S.A.

Contact : Dr. Thomas Hoffer.

Activities :

Developing reference documents for estimating atmospheric characteristics for Wind Energy Conversion Systems (WECS) design.

Budget :

FY 1979 - $19,000 (Wind energy project).

Lead Laboratory :

Pacific Northwest Laboratory, Richland.

Funding Source :

DOE.

Publications :

Reports to be published on current estimates of atmospheric characteristics for use in WECS design. A report is planned to be published on two icing types : freezing rain and rime-icing.

16. Development Planning & Research Association,
Post Office Box 727,
Manhattan, Kansas,
U.S.A.

Telephone : 913-539-3565

U.S.A.

Contact : John P. Wagner, Economist.

Activities :

1) Economical analysis : Agricultural wind energy applications.
2) Market research.

Lead Agency :

U.S. Dept. of Agriculture, Beltsville.

Funding Source :

DOE.

17. Division of Energy & Economic Development,
Div. of Energy & Power Development,
7th floor, MacKay Building,
338, Denali Street,
Anchorage, Alaska 99501,
U.S.A.

Telephone : 907-276-0508.

Contact : Donald R. Markle, Energy Project Manager

Activities :

Wind energy work commenced in 1978.
Specific activities include :
1) Wind data collection and evaluation.
2) Research and development.

Budget :

$500,00 per annum.

Funding Source :

State of Alaska General Fund and Dept. of Energy, Washington.

Windmill Installations :

Laboratory scale, demonstration units and functioning horizontal axis windmill for power generation. There are 50 systems installed in Alaska. Inter-tie system and stand-alone are being used for practical applications

U.S.A.

18. Electric Power Research Institute (EPRI),
Communication Division,
Box 10412,
Palo Alto, CA. 94303,
U.S.A.
Telephone : (415) 855-2000 Telex : 910-373-1163

Contact : Frank R. Goodman, Jr. Project Manager.

Activities :

Wind energy work commenced in 1976.
EPRI selects, funds, and manages research projects to develop new ways to produce, transmit and distribute electric power. Other activities include : (a) Wind turbine siting methodology, (b) utility impact analyses, and (c) wind turbine performance assessments.

Publications :

Programme summaries, technical reports. Publishes 'EPRI Guide' which contains ordering information and annotations for all EPRI research project reports, reprints of 'EPRI Journal' fact sheets and other miscellaneous printed items.

Budget :

$262 million (total 1980 funding for all EPRI research programmes).

Funding Source :

Approx. 640 member utilities throughout U.S.

19. Energy Resources Co.,Inc.,
185, Alewife Brook Parkway,
Cambridge, Mass. 02138,
U.S.A.
Telephone : 617-661-3111 Telex : 710-320-0721

Contact : Dr. John B. Edwards, Vice President.

U.S.A.

Activities :

Wind energy work commenced in 1978.
Specific activities are :
1) Wind data collection and evaluation.
2) Extension/promotion.
3) Policy formulation/programme evaluation.
4) Financing/supporting.

Funding Source :

Internal/DOE.

Personnel :

John Edwards, Ron Beck, Richard Rosen,
David Myers.

20. Energy Utilization Systems, Inc., (EUS),
365, Plum Industrial Court,
Pittsburgh, Pennyslvania 15239,
U.S.A.
Telephone : 412-325-2820 Telex : TWX:510-468-5771

Contact : Robert L. Dunning, President.
Barry D. Sloane, Manager of Consulting.

Activities :

Wind energy work commenced in 1978.
Main activities are :
1) Wind data collection and evaluation.
2) Research and development : Providing support for Demonstration VAWT/Electri Utility Project.

Publications :

Reports of the above project to be published.

Budget :

$20,000 for the wind energy project.

Funding Source :

National Rural Electric Cooperative Association (NRECA).

U.S.A.

21. * Environmental Systems Corp.,
P.O. Box 2525,
Knoxville, TN. 37901,
U.S.A.

Contact : T.B. Carlson.

Activities :

Meteorological measurements at candidate sites and meteorological measurements at wind turbine sites.

Budget :

FY 1979 - $686,000 (Wind energy project).

Lead Laboratory :

Pacific Northwest Laboratory, Richland.

Funding Source :

DOE.

Publications :

Casette wind data tapes collected at each site from which data reports are prepared.

22. * EMR Teremetry, Inc.,
P.O. Box 3041,
Sarasota, Florida 33578,
U.S.A.

Contact : Harold Neustadter.

Activities :

Acquiring, processing and analysing the engineering data generated during all wind turbine operations (including MOD-O in the near future) and to convert these data into useful information. This task began in 1976 and will continue till 1984.

U.S.A.

Budget :

FY 1979 - $345,000 (wind energy project).

Lead Agency :

NASA Lewis Research Center, Cleveland.

Funding Source :

DOE.

23. * Flow Industries, Inc.,
21414 68th Avenue,
Kent, WA. 98031,
U.S.A.

Contact : James U. Riley.

Activities :

Studies on wind turbine wake flow.

Budget :

FY 1979 - $29,000 (wind energy project).

Lead Laboratory :

Pacific Northwest Laboratory, Richland.

Funding Source :

DOE.

Publications :

Plans to publish an annotated bibliography of significant papers related to wind machine wake effects.

U.S.A.

24. * FWG Associates, Inc.,
R.R. 3, Box 331,
Tullahoma, TN. 37388,
U.S.A.

Contact : Dr. Walter Frost.

Activities :

1) Study to characterize the effects of micro-scale terrain features on near surface wind (for selecting sites for WECS installations).
2) Performing error estimate calculations for a set of four wind characteristics reported in the NASA handbook for design of wind turbines.

Budget :

FY 1979 - $51,000 (wind energy project).
FY 1979 - $27,000.

Lead Laboratory :

Pacific Northwest Laboratory, Richland.

Funding Source :

DOE.

Publications :

Technical reports, research papers. Plans to publish a handbook containing methods in selecting an optimum site for a WECS within a small area.

25. * General Electric Company,
P.O. Box 8661,
Philadelphia, PA. 19101,
U.S.A.

Contact : W.H. Robbins, John Collins.

U.S.A.

Activities :

Developing 2 MW, horizontal axis, propeller type experimental wind turbine generator with 2 rotor blades 200 feet in diameter (MOD-1 Project). Installed at Boone, North Carolina.

Budget :

FY 1979 - $3,800,000 (wind energy project).

Lead Agency :

NASA Lewis Research Center.

Funding Source :

DOE.

Cooperating Utility :

Blue Ridge Electrical

Publications :

Reports (engineering and performance data of 2 MW wind turbine).

26. * GEOMET, Inc.,
Gaithersburg, MD. 20760,
U.S.A.

Contact : Ken Pickering.

Activities :

Produce regional assessment of wind data for Northeast Region of U.S.A.

Budget :

FY 1979 - $90,000 (wind energy project).

Lead Laboratory :

Pacific Northwest Laboratory, Richland.

U.S.A.

Funding Source :

DOE.

27. Georgia Institute of Technology,
School of Geophysical Sciences,
Atlanta, GA. 30332,
U.S.A.

Telephone : 404-894-3890

Contact : C.G. Justus.

Activities :

Work began in 1974.
Activities include :
Evaluating turbulence effects on wind turbine performance as well as monthly and annual variation in mean windspeed (the annual variability of wind power of 40 National Weather Service Stations with mean windspeed greater than 5 m/s has been studied).

Lead Laboratory :

Pacific Northwest Laboratory, Richland.

Funding Source :

DOE.

Publications :

Technical reports, research papers.

Windmill Installations :

Demonstration unit, horizontal axis windmill for power generation.

U.S.A.

28. * Global Weather Consultants,
San Jose,
CA. 95113,
U.S.A.

Contact : Richard L. Simon.

Activities :

Produce regional assessment of wind data for Southwest Region of U.S.A.

Budget :

FY 1979 - $56,000 (for wind energy project).

Lead Laboratory :

Pacific Northwest Laboratory, Richland.

Funding Source :

DOE.

29. * Gougeon Brothers, Inc.,
705, Martin St.,
Bay City, MI. 48706,
U.S.A.

Contact : M. Gougeon.

Activities :

Developing low cost wind turbine blade fabrication methods. The task was initiated in 1978 and will continue till 1982. The first set of blades from Gougeon Bros., was delivered in March 1980.

Lead A ency :

NASA Lewis Research Center, Cleveland.

Funding Source :

DOE.

30. * Grumman Aerospace Corp.,
South Oyster Bay Road,
Bethpage, N.Y. 11714,
U.S.A.

Contacts : James T. Yen.
K.M. Foreman.

Activities :

1) Development and testing of Tornado Type Wind Energy System (TTWES).
2) Investigating Diffuser Augmented Wind Turbine (DAWT).

Lead Laboratory :

Solar Energy Research Institute, Colorado.

Funding Source :

DOE.

Publications :

Research papers and reports on above activities.

31. * Hibbitt & Karlsson,
North Scituate, RI. 02857,
U.S.A.

Contact : H.D. Hibbitt.

Activities :

Developing a computer capability for the prediction of stress, deflection and structural vibration of Darrieus Turbine.

Budget :

FY 1979 - $48,500 (wind energy project).

Lead Laboratory :

Sandia Laboratories, Albuquerque.

U.S.A.

Funding Source :

DOE.

Publications :

Technical reports.

32. * IIT Research Institute,
10, West 35th Street,
Chicago, IL. 60616,
U.S.A.

Contact : K. Hofer.

Activities :

Developing low cost wind turbine blade fabrication methods. This task was initiated in 1978 and will continue till 1982. The effort included full-scale (MOD-OA) blade design and fabrication phases. A contract was also awarded to IITRI for fatigue testing to support the composite blades.

Lead Agency :

NASA Lewis Research Center, Cleveland.

Funding Source :

DOE.

33. International Wind Energy Institute,
Route 1, Box 93-A,
Oskaloosa, Kansas 66066,
U.S.A.

Telephone : 913-842-0298

Contact : Steve Blake.

Activities :

Work commenced in 1972.
Specific activities include :

U.S.A.

1) Wind data collection and evaluation.
2) Research and development.
3) Policy formulation/programme evaluation.
4) Financing/supporting.

Publications :

Books and monographs.

Funding Source :

Private donors; U.S. Dept. of Energy.

34. Iowa State University,
213, Davidson Hall.
Ames, IA. 50011,
U.S.A.

Telephone : 515-294-5723

Contact : Dr. L.H. Soderholm, Research Leader.

Activities :

Wind energy work began in 1974.
Main activities are :
1) Wind data collection and evaluation.
2) Research and development : Wind power for heating farm structures.
3) Demonstration of agricultural applications (sponsored 1979 Workshop on Wind Energy Applications in Agriculture).

Publications :

Research papers. Conference Proceeding (Wind Energy Application in Agriculture USDA Wind Workshop Proceeding 1979).

Budget :

$60,000 per annum.

Lead Agency :

Dept. of Agriculture.

U.S.A.

Funding Source :

DOE.

Windmill Installations :

Demonstration units and functioning horizontal axis windmills for agricultural tasks.

35. * JBF Scientific Corp.,
2, Jewel Drive,
Wilmington, MA. 01887,
U.S.A.

Contact : Theodore R. Korneich.

Activities :

Generic study of vortex extraction Wind Energy Systems.

Budget :

FY 1979 - $24,950 (wind energy project).

Lead Laboratory :

Solar Energy Researc.. Institute, Colorado.

Funding Source :

DOE.

Publications :

Technical reports.

36. * JDB & Co.,
1629, K. Street,
N.W. Suite 700,
Washington D.C. 20006,
U.S.A.

Contact : Thomas G. Bolle.

U.S.A.

Activities :

Market development of Small Wind Energy Conversion Systems.

Budget :

FY 1979 = $800,000 (wind energy project).

Lead Laboratory :

Rockwell International, Colorado.

Funding Source :

DOE.

Publications :

Technical reports.

37. Lawrence Livermore National Laboratory,
Atmospheric & Geophysical Sciences Div.,
Physics Dept., P.O. Box 808,
Livermore, CA. 94550,
U.S.A.

Telephone : (415) 422-1800 Telex : (TWX-910-386-8339 UCLLL LVMR)

Activities :

1) Wind data collection and evaluation.
2) Research and development : Several studies have been made on wind power yield measurement conducted in conjunction with numerical analyses of regional wind energy. A computational site screening methodology for wind energy has been developed at Lawrence Livermore Laboratory.

Budget :

FY 1976 - $70,000.
FY 1977 - $236,000.
FY 1978 - $240,000.

Funding Sources :

Energy Research and Development Administration/
Dept. of Energy.

Personnel :

Staff of 11.

38. * Marlatt & Associates,
3611, Richmond Drive,
Ft. Collins, CO. 80521,
U.S.A.

Contact : W.E. Marlatt.

Activities :

Develop procedure for using National Fire data to estimate wind energy in Forest Service regions.

Budget :

FY 1979 - $26,000 (for wind energy project).

Lead Laboratory :

Pacific Northwest Laboratory, Richland.

Funding Source :

DOE.

39. Massachusetts Institute of Technology,
Dept. of Aeronautics & Astronautics,
Cambridge, MA. 02139,
U.S.A.
Telephone : (617)-253-3758

Contact : Prof. R.H. Miller.
Prof. J. Dugundji.

Activities :

Wind energy work began in 1975.
Main activity is :
Basic research into horizontal wind turbine structural dynamics, aerodynamics and drive train dynamics.

U.S.A.

Budget :

Approx. $70,000/year.

Fundin: Sources :

National Science Foundation; NASA Lewis Research Center.

Publications :

More than 10 reports on aerodynamics, dynamic studies of horizontal axis wind turbines, wake analysis, etc.

Windmill Installations :

1 horizontal axis windmill model (3 ft. diameter) for demonstration and for vibration and aerodynamic performance investigations.

Personnel :

R.H. Miller, J. Dugundji, M. Martinez-Sanchez, J. Wendell, B. Liebst, A. Kamoulakos, A. Tanuwidjaja.

40. Metrek Div., Mitre Corp.,
661, Thornbill Rd.,
Danville, CA. 94526,
U.S.A.

Telephone : 415-422-6555

Contact : Dr. M.R. Gustavson.

Activities :

Wind energy work commenced in 1970.
Specific activities include :
1) Research and development.
2) Policy formulation/programme evaluation.
3) Advisory service : Private consultants to government and industry on energy and resource evaluation and planning.

U.S.A.

Publications :

Research papers.

41. Montana Energy & HAD Research & Development Institute,
P.O. Box 3809,
Butte, MT. 59701,
U.S.A.

Telephone : 406-494-6204

Contact : Dr. Edgar A. O'Hair.

Activities :

Wind energy work began in 1978.
Specific activities include :
1) Wind data collection and evaluation.
2) Research and development : Horizontal axis wind turbine for power generation.
3) Extension/promotion.

Publications :

Technical reports.

Budget :

$100,000 per annum.

Personnel :

Dr. Edgar A. O'Hair and Lane Branson.

42. * NASA,
Lewis Research Center,
Large Wind Turbine Program,
2100 Brook Park Road,
Cleveland, OH. 44135,
U.S.A.

Contacts : Publications
Jerry Kennard
Tel: 216-433-4000

Technical Information
Ron Thomas
Tel: 216-433-4000

U.S.A.

Activities :

NASA is responsible for The Large and Intermediate Systems Development Program of DOE.

1) Technical management of intermediate and megawatt scale wind energy systems such as the MOD-O, MOD-OA, MOD-1 and MOD-2 Wind Energy Systems Projects.
2) Intermediate-Scale Project : Obtain performance data and gain experience in operation of large wind turbines in typical user environments.
3) Megawatt-Scale Wind Energy Systems Program : Accelerate development and commercial use of reliable and economic wind turbine generators.

Funding Source :

Dept. of Energy (DOE), Washington.

Characteristics of Intermediate & Large Wind Turbines

Type	Rotor Diameter	Capacity/Rated Wind Speed (at 30 ft.)	Location	Firs[illegible]
MOD-0	125 ft.	100 kW/18 mph	Plum Brook, OH	FY 19[illegible]
MOD-0A	125 ft.	200 kW/22 mph	Clayton, NM	FY 19[illegible]
			Culebra, PR	FY 19[illegible]
			Block Island, RI	FY 19[illegible]
			Oahu, HI	FY 19[illegible]
MOD-1	200 ft.	2 MW/26 mph	Boone, NC	FY 19[illegible]
MOD-2	300 ft.	2.5 MW/20 mph	Goldendale, WA	FY 19[illegible]
MOD-5	TBD*	TBD*	TBD*	FY 19[illegible]
MOD-6H	TBD*	TBD*	TBD*	FY 19[illegible]
MOD-6V	TBD*	TBD*	TBD*	FY 19[illegible]

* To be determined.
H = horizontal axis wind turbine
V = vertical axis wind turbine

U.S.A.

43. Naval Construction Battalion Center,
Civil Engg. Lab.,
Port Hueneme, CA. 93043,
U.S.A.

Telephone : 805-982-4207

Contact : Dharam Pal, Mech. & Electrical Engg. Dept.

Activities :

The Navy recognized the potentials of wind power in 1974. Main activity is
Navy utilization of Wind Energy Conversion Systems.
4 demonstration programmes using commercial wind turbine generators are currently in progress.

Publications :

Technical reports and research papers (Wind Generated Electric Power at Navy Bases).

Windmill Installations :

Demonstration units of horizontal and vertical axis windmills for power generation at the navy bases.

Personnel :

4 full-time persons.

44. The New Alchemy Institute,
237, Hatchville Road,
East Falmouth, MA. 02536,
U.S.A.

Contact : Gary Hirshberg, Wind & Education.
Joseph Seale, Wind & Solar Design.

Activities :

In the area of wind energy, following are the activities :

1) Development of a sail wing water pumping windmill being used for a wind powered

aquaculture system.
2) Windmill design modelling: A computer based model to assist designers in picking the best match of gearing and load for any given system and wind regime.
3) Windmill refrigeration: An analysis of the feasibility of using a direct drive windmill to power refrigeration freezing and heating system, with no intermediate conversion to electricity is presently underway.

Publications :

Journal of the New Alchemists; The New Alchemy Newsletter, and The Book of the New Alchemists.

Funding Source :

Private contributions and membership fees (2500 members); U.S. Dept. of Energy (for wind energy project).

45. New Mexico Solar Energy Institute,
Box 3 SOL, Las Cruces,
New Mexico 88003,
U.S.A.

Telephone : 505-646-1846

Contact : Dr. Schoenmackers/Dr. Barnett.

General Information :

In 1977, the New Mexico State Legislature established the New Mexico Solar Energy Institute whose research activities include solar heating, cooling, photovoltaic demonstration, biomass and wind energy technologies

Activities :

1) Several Demonstration Projects.
2) Wind Resource Assessments.
3) Training and Workshops.
4) Information Dissemination.

Budget :

$30,000 plus contracts.

U.S.A.

Funding Source :

State of New Mexico.

Publications :

Programme Summaries - 'The New Mexico Wind Energy Program' Aug. 1980. Technical reports, research papers, review/surveys, bibliographies, brochures and pamphlets on wind energy. Poster - 'Wind Energy in New Mexico.'

Windmill Installations :

Vertical Axis Windmills :	Demonstration unit - power for farmhouse.
Horizontal Axis Windmills :	Demonstration unit - power for irrigation and electrical heating. Demonstration unit - Utility interconnected. Demonstration unit - power for highway rest stop.

46. New Mexico State University,
Physical Science Lab.,
P.O. Box 3 - PSL,
Las Cruces, NM. 88003,
U.S.A.

Telephone : 505/522-2785

Contact : Ralph D. Reynold, Meteorologist.
Kenneth M. Barnett.

Activities :

Wind energy work commenced in 1976.
Specific activities include :

1) Wind data collection and evaluation.
2) Research and development : Identify cost effective measurement systems for Wind Energy Conversion sites.

Budget :

$50,000 per annum.

Funding Source :

State of New Mexico - Dept. of Energy & Minerals, Pacific Northwest Laboratory/DOE (for wind energy project).

Publications :

Technical reports.

Windmill Installations :

Demonstration unit of horizontal axis windmill.

47. * NOAA,
Technical Development Lab.,
National Weather Service,
Silver Spring, MD. 20910,
U.S.A.

Contact : Dave Gilhausen.

Activities :

Examining reliability of deterministic and probabilistic wind forecasts.

Budget :

FY 1979 - $40,000 (wind energy project).

Lead Laboratory :

Pacific Northwest Laboratory.

Funding Source :

DOE.

U.S.A.

48. * North American Weather Consultants,
Goleta, CA. 93017,
U.S.A.

Contact : M.W. Edelstein.

Activities :

Obtain quantitative estimates of long-term wind data-sparse areas.

Budget :

FY 1979 - $10,000 (for wind energy project).

Lead Laboratory :

Pacific Northwest Laboratory, Richland.

Funding Source :

DOE.

Publications :

Technical reports.

49. Northwestern University,
Civil Engg. Dept.,
Evanston, IL. 60201,
U.S.A.

Telephone : 312-492-3453

Contact : Prof. Ross B. Corotis.

Activities :

Work began in 1976 to develop stochastic and probablistic methods for evaluating wind characteristics at potential wind turbine sites.

Lead Laboratory :

Pacific Northwest Laboratory, Richland.

Funding Source :

DOE.

Publications :

Several technical reports and research papers on various wind characteristics.

50. Oklahoma State University,
School of Electrical Engg.,
Engg. Energy Lab.,
202, Engineering South/216, Engg. South,
Stillwater, OK. 74078,
U.S.A.

Telephone : 405 624 5170
5151
5157

Contact : Dr. R. Ramkumar or Dr. William L. Hughes

Activities :

Work began in 1960.

1) Past work includes development of special generator systems and electrolysis cells (for energy storage) for wind energy conversion systems; development and testing of bicycle-wheel type wind turbines; modelling and stability studies.
2) At present, work is primarily concentrated in modelling and information dissemination areas. Special emphasis is being given to developing country applications.

Budget :

Nearly U.S. $600,000 during the past 20 years of which $400,000 was spent during 1973-77.

Funding Sources :

Area utility companies; National Science Foundation, Washington D.C.; U.S. Dept. of Energy; State of Oklahoma.

Publications :

Technical reports and research papers on various topics of wind energy, review/surveys.

U.S.A.

Windmill Installation :

Horizontal Axis Windmills : During 1973-77, there were two turbines - 15ft diameter and 30 ft diameter turbine of the bicycle-wheel type, driving field modulated generators and operating in the variable-speed mode to maintain a constant tip speed ratio. They were operated, data gathered and analyzed and the installation has been dismantled as the projects reached their proper concluding stages.

Personnel :

9 past and present (1 from New Zealand and 1 from Pakistan).

51. Oregon State University,
Corvallis, OR. 97331,
U.S.A.

Telephone : 503-754-4557 Telex : 510-596-0680

Contact : E.W. Hewson.
J.R. Connell (Dept. of Atmospheric Sciences)
Larry J. Mahrt (Dept. of Atmospheric Sciences)
Robert Wilson

Activities :

Wind energy work commenced in 1979.

1) Determine the feasibility of using wind deformation of vegetation as an indicator of mean wind velocity.
2) Provide methods for measuring and analyzing wind near a WECS for performance evaluation.
3) Determine the statistics of strong nocturnal wind shears for wind machine design.
4) Research and development of Darrieus turbine (pursued at Sandia Lab. since 1975).

U.S.A.

Budget :

$70,000 per annum.

Lead Laboratories :

Pacific Northwest Laboratory, Richland; Sandia Laboratories, Alburuqeque.

Fundin: Source :

DOE.

Publications :

Several technical reports.

52. Pacific Northwest Laboratory,
Wind Energy Program,
Battelle Blvd., P.O. Box 999,
Richland, WA. 99352,
U.S.A.

Contact : Publications :
Pamela Partch
Tel: 509-942-4410

Technical Information :
Larry Wendell, Manager, [illegible] Characteristics
Tel: 509-942-4626

Activities :

PNL is responsible for the Wind Characteristic Element Program of DOE.

1) Provides meteorological information for site determination for various wind energy projects.
2) Provides wind characteristic support for design and operation.
3) Conducts technical work through contracts with private research firms and universities and through in-house efforts.
4) Consolidates information into formats designed for audiences with specific needs.

Funding Source :

Dept. of Energy (DOE), Washington.

U.S.A.

Publications :

Publication List (1980). Several technical reports on wind characteristics.

53. Paragon Pacific, Inc.,
1601 East El Segunda Boulevard,
El Segunda, CA. 90245,
U.S.A.

Contact : D. Spera.

Activities :

Provides analytical support to the NASA Wind Energy Project Office.

Budget :

FY 1979 - $133,000 (wind energy project).

Lead Agency :

NASA Lewis Research Center, Cleveland.

Funding Source :

NASA Lewis Research Center, Cleveland.

Publications :

Technical reports (MOSTAS code-rigid hub version; WEST-Wind Energy System, Time-Domain analog/digital simulators).

54. Pennysilvania State University,
University Park, PA. 16802,
U.S.A.

Telephone : 814-865-0478

Contacts : A.K. Blackadar, Head, Dept. of Meteorology.
H.A. Panofsky.

U.S.A.

Activities :

Main activity is wind research.
Study of turbulence characteristics over non uniform terrain.

Budget :

FY 1979 - $12,000 (wind energy project).

Lead Laboratory :

Pacific Northwest Laboratory, Richland.

Funding Source :

National Science Foundation; DOE.

Publications :

Reports of the above study.

55. * Perdue University,
West Lafayette, IN. 47907,
U.S.A.

Contact : D.M. Triezenberg.

Activities :

The project on Wind Turbines Clusters/Grid-Simulator which began in 1979, was expected to be completed in 1980. Detailed analog computer models of the MOD-2 Wind Turbine will be established at NASA and at Purdue.

Budget :

FY 1979 - $49,870 (wind energy project).

Lead Agency :

NASA Lewis Research Center, Cleveland.

Funding Source :

DOE.

U.S.A.

Publications :

Report presented at a seminar on wind turbine modelling. Two papers describing wind turbine model and its performance were presented by NASA at wind energy conferences.

56. * Polytechnic Institute of New York,
Route 110,
Farmingdale, N.Y. 11735,
U.S.A.

Contact : Pasquale M. Sforza.

Activities :

Research and development : Delta wing Vortex Augmentors concept (VAC) for wind energy conversion.

Funding Source :

Internal and Dept. of Energy, Washington.

57. * Power Technology, Inc.,
P.O. Box 1058,
Schenectady, N.Y. 12301,
U.S.A.

Contact : E.N. Hinrichsen.

Activities :

Provide design information for wind turbines and the utility interface.

Budget :

FY 1979 - $57,500 (for wind energy project).

Lead Agency :

NASA Lewis Research Center, Cleveland

U.S.A.

Fundin: Source :

DOE.

Publications :

Technical reports (specific design requirements for wind turbine; specific utility interface design).

58. * Raytheon Service Co.,
2, Wayside Road,
Burlington, MA. 01803,
U.S.A.

Contact : Chester A. Wendell.

Activities :

Provide technical management functions such as planning, specifying, coordinating, monitoring and reporting the activities of contractors and users of the Federal Wind Energy Programme.

Budget :

FY 1979 - $650,000 (wind energy programme).

Funding Source :

DOE, Washington.

59. * Regional Systems Service Group,
5680, South Syracus Circle,
Suite 514,
Englewood, CO. 80111,
U.S.A.

Contact : Wayne Stafford.

Activities :

1) Economic analysis of Wind Energy Conversion System both for individual ownership and utility ownership.

2) Wind Energy technical information dissemination: Planning guide for community.

Lead Laboratory :

Solar Energy Research Institute, Colorado.

Funding Source :

DOE.

Publications :

A complete guide for a feasibility study of a municipally owned wind energy system will be prepared.

60. Rocky Flats Plant,
Wind Energy Program,
Rockwell International Energy Systems Group,
P.O. Box 464,
Golden, CO. 80401,
U.S.A.

Contact : Publications :

Darrell Dodge
Tel: 303-441-1300

Technical Information :

Terry Healy
Tel: 303-441-1300

Activities :

Rockwell International is responsible for the DOE Field Evaluation Program.

1) Manages a test center for commercially available wind systems.
2) Supports the existing wind energy industry through testing research and development: In 1979, the Rocky Flats Test Center was testing 18 small wind energy conversion systems and will be testing more than 50 in 1981.
3) Advanced systems in 5 output ranges (1-2, 4, 8, 15 and 40 kw) are being developed by private industry under subcontract to Rockwell.

U.S.A.

4) Researches technical issues and barriers to Small Wind Energy Conversion Systems use.

Funding Source :

Dept. of Energy (DOE), Washington.

61. * Sandia Laboratories,
Wind Systems Program,
Div. 4715,
Albuquerque, NM. 87185,
U.S.A.

Contacts : Publications :

Sandia Document Distribution
Tel: 505-264-3850

Technical Information

Tel: 505-264-8600

Activities :

1) Developing and testing Darrieus Vertical Axis Wind Turbines (VAWT).
2) Future efforts are aimed at developing cost and performance data evaluating first generation industrial designs, investigating design improvements and improving analysis methods for use by private decision makers.

Funding Source :

U.S. Dept. of Energy, (DOE).

62. * Science Applications, Inc.,
P.O. Box 2351,
La Jolla, CA. 92038,
U.S.A.

Contact : R.M. Traci.
Dr. Eugene Buell.

Activities :

A 3-year program to develop, test and perform prototype applications of a Wind energy Conversion system site-selection methodology has been

completed. Work is being extended to verify the computer codes developed in the program.

Budget :

FY 1979 - $45,000 (wind energy project).

Lead Laboratory :

Pacific Northwest Laboratory, Richland.

Funding Source :

DOE.

Publications :

Computer codes have been documented. Siting methodology has been documented and demonstrated. Final report will contain results of two model verification tests.

63. * Simpson Weather Association,
P.O. Drawer 5508,
Charlottesville, VA. 22903,
U.S.A.

Contact : Dr. M. Garstang.

Activities :

Use of wind energy to assist in solar desalting to obtain potable water.

Budget :

FY 1979 - $13,000.

Lead Laboratory :

Pacific Northwest Laboratory, Richland.

Funding Source :

DOE.

Publications :

Reports of the above project.

U.S.A.

64. Solar Energy Research Institute,
Wind Energy Branch,
1617, Cole Blvd.,
Golden, CO. 80401,
U.S.A.

Contacts : Publications :

Document Distribution Service
Tel: 303 231 1158

Technical Information

Irwin Vas
Tel: 303 231 1935

Activities :

SERI has lead laboratory responsibility for the Research and Analysis Element of the Federal Wind Energy Program.

1) Technical management of economic and application studies.
2) Investigates institutional issues.
3) Manages technical information dissemination.
4) Administers The Wind Energy Innovative Systems Program (solicit, evaluate and develop innovative and advanced wind energy systems).

Budget :

Approx. $5 m in FY 1981.

Funding Source :

U.S. Dept. of Energy (DOE), Washington.

Publications :

Several technical reports and research papers on various topics of wind energy; SERI wind brochures, wind energy reading list; 'The DOE Wind Energy Program Poster'; Directories - 'Wind Energy Information Directory, May 1980'. A wind related U.S. manufactures list is being prepared.

65. * South Dakota School of Mines & Technology,
Rapid City, SD. 57701,
U.S.A.

Contact : Thomas K. Oliver.

Activities :

Research and development : Energy from humid air.

Budget :

FY 1979 - $68,975.

Funding Source :

Dept. of Energy, Washington.

66. * SRI International,
333, Ravenswood Avenue,
Menlo Park, CA. 94025,
U.S.A.

Contact : Dr. Chandrakant Bhumralkar.

Activities :

Estimating wind characteristics at candidate sites.

Budget :

FY 1979 - $69,000.

Lead Laboratory :

Pacific Northwest Laboratory, Richland.

Funding Source :

DOE.

67. State University of New Mexico
at Buffalo,
Dept. of Mech. & Aerospace Engg.,
Room 612, Furnas Hall,
Amherst, N.Y. 14260,
U.S.A.

Telephone : 716-636-2727

U.S.A.

Contact : Prof. Niels H. Juul.

Activities :

Wind energy work commenced in 1977.
Specific activities include :
1) Wind data collection and evaluation.
2) Research and development: Propeller type wind turbine.
3) Education: Wind Power Engineering courses introduced at graduate and undergraduate levels since 1979.

Publications :

Research papers ('Optimum Design Point Geometry and Performance of Propeller Type Wind Turbine').

Windmill Installations :

Laboratory scale, horizontal and vertical axis windmills.

Personnel :

Prof. Juul and few students.

68. Structural Composites Industries, Inc., (SCI),
6344, North Irwindale Ave.,
Azusa, CA. 91702,
U.S.A.

Telephone : 213-334-8221.

Contact : Vicki L. Morris, Marketing Engineer.

Activities :

1) Developing low cost wind turbine blade fabrication methods. The task was initiated in 1978 and will continue till 1982.
2) Developing 4 kw wind turbine generator which consists of two phases : I- design and component development, II - prototype fabrication and testing.

Funding Source :

U.S. Dept. of Energy.

Publications :

Design reviews of SCI blades and technical papers on the development of the 4KW Wind Turbine Generator.

69. * SW Research & Development Co.,
1825, Imperial Ridge,
Las Cruce, New Mexico 88001,
U.S.A.

Contact : R. Landsford.

Activities :

Economic analysis of irrigation pumping.

Funding Source :

U.S. Dept. of Agriculture, Beltsville.

Publications :

Technical reports.

70. * Systems Control, Inc.,
1801 Page Mill Rd.,
Palo Alto, CA. 94304,
U.S.A.

Contact : Fred S. Ma

Activities :

Identifying the concerns and impacts of Small Wind Energy Conversion Systems, interconnected with utility systems.

U.S.A.

Budget :

FY 1979 - $112,000.

Lead Laboratory :

Rockwell International, Colorado.

Funding Source :

DOE.

Publications :

Technical reports.

71. * Tennesse Valley Authority,
345, Commerce Union Bank Bldg.,
Chattanooga, Tennessee 37401,
U.S.A.

Contact : D.W. Hilson.

Activities :

Analysis of operation of an electric power system with and without wind generation.

Budget :

FY 1979 - $198,000.

Funding Source :

DOE, Washington.

Publications :

Technical reports.

U.S.A.

72. * Tetra-Tech, Inc.,
911, Fort Myer Dr.,
Suite 601,
Arlington, VA. 22206,
U.S.A.

Contact : W. Garling, Mark Harper.

Activities :

1) Economic analysis of wind-powered grain (crop) drying system.
2) Generic study of augmented vertical-axis wind energy systems.

Funding Source :

DOE.

Leading Agency/Lab. :

U.S. Dept. of Agriculture, Beltsville; Solar Energy Research Institute.

Publications :

Technical reports.

73. * Texas Technology University,
Dept. of Mechanical Engg.,
Lubbock, TX. 79409,
U.S.A.

Contact : J.H. Strickland.

Activities :

Developing a theoretical aerodynamic model to predict experimental results for Darrieus wind turbine. A computer code has been developed for the simulation of turbine blades and wakes by time dependent vortices.

Budget :

FY 1979 - $39,890 (wind energy project).

U.S.A.

Lead Laboratory

Sandia Laboratories, Albuquerque.

Funding Source :

DOE.

Publications :

Technical reports.

74. U.S. Atmospheric Sciences Laboratory,
White Sand Missile Range (W.S.M.R.),
NM. 88002,
U.S.A.

Telephone : 505-678-1227

Contact : Dr. Henry Rachele, Dy.Director, ASL.

Activities :

Wind energy work commenced around 1978-79.
Main activities are :
1) Assisting other agencies to determine feasibility of wind-generated power at White Sand Missile Range.
2) Wind measurement (turbulence, wind speed, wind direction) using atmospheric wind flow models.

Publications :

Programme summaries (feasibility of wind/solar energy for WSMR).

Funding :

U.S. Army.

Windmill Installations :

Type of windmill : Horizontal axis, UVW's, remote sensors (LDV's rawinsondes).
Applications : Alternate electricity source and water pumping.

U.S.A.

75. U.S. Department of Agriculture,
Agricultural Research Services,
Beltsville, MD. 20705,
U.S.A.

Contact :

Publications :

Govt. Public Affairs,
Information Desk, USDA,
Room 100W,
14th Independence,
Washington D.C. 20250.

Technical Information

Louis Liljedahl
202-447-3504

Activities :

1) Manages projects to identify design and performance requirements for farm and agricultural use of wind systems.
2) The main objectives are to determine promising agricultural applications of wind energy, define agricultural mark for wind systems and specify research and development projects which could lead to increased use of wind systems in the agricultural sectors.
3) The six USDA field experiments which form a part of the Proof of Concept Field Program are (a) Wind Powered Farmhouse Heating. (b) Apple Storage Cooling. (c) Low-Lift Irrigation Pumping. (d) High-Lift Irrigation Pumping. (e) Dairy Milk Cooling and (f) Direct Mechanical Conversion to Heat.

Budget :

U.S. Dept. of Energy (DQE).

76. U.S. Department of Agriculture,
Conservation & Production Laboratory,
P.O. Drawer 10,
Bushland, Texas 79012,
U.S.A.

Telephone : 806-376-2534

U.S.A.

Contact : R. Nolan Clark.

Activities :

Research and development.

Publications :

Technical reports.

Budget :

$150,000 per annum.

Funding Sources :

U.S. Department of Agriculture and U.S. Department of Energy.

Windmill Installations :

Vertical axis and horizontal axis windmill for water pumping and power generation.

77. U.S. Department of Agriculture,
Wind Energy Research Unit,
Room 204, Waters Hall,
Kansas State University,
Manhattan, Kansas 66506,
U.S.A.

Contact : L. J. Hagen.

Activities :

Work commenced in 1977.
Specific activities include :
1) Wind data collection and evaluation.
2) Research and development : Darrieus applications.

Publications :

Technical reports and research papers ('Application of Wind Energy to Greater Plains Irrigation Pumping' (1980)).

U.S.A.

rganization	Activity
dia Laboratories querque, New Mexico	Development of vertical axis wind turbine technology.

Budget :

$87 m per annum.

Additional Information :

For DOE supported projects refer 'Wind Energy Systems Program Summary' May 1980.

79. United Technologies Research Center,
Silver Lane,
East Hartford, CT. 06108,
U.S.A.

Telephone : 203-727-7536

Contact : Marvin C. Cheney, Program Manager.

Activities :

1) Research and development: Oscillating vane concept applied to wind energy conversion.
2) Development of a 8 kw and a 15 kw Wind Turbine Generator.

Funding Source :

U.S. Department of Energy.

Publications :

Research papers, reports reviewing 8 kw system. Documentation and detailed drawings of 8 kw and 15 kw systems.

U.S.A.

Windmill Installations :

Demonstration units of vertical axis windmill for water pumping application.

78. U.S. Department of Energy (DOE),
Asst. Secretary for Conservation & Solar Energy,
Office of Solar Power Applications,
The Wind Energy Systems Branch,
Washington D.C. 20585,
U.S.A.
Telephone : 202-376-4878

Contact : Louis V. Divone, Director.

Activities :-

The main objectives of the U.S. Federal Wind Energy Program are :
1) To accelerate the development of reliable and economically viable wind energy systems.
2) To assure the earliest possible commercialization of wind power.

Responsibility for various aspects of the program within the federal structure is divided as follows :

Organization	Activity
Solar Energy Research Institute, Golden, Colorado	Economic, institutional, enviro[illegible] market analysis, innovative [illegible] research and information disse[illegible]
U.S. Department of Agriculture Beltsville, Maryland	Agricultural, rural and remote [illegible] of small wind systems.
NASA Lewis Research Center Cleveland, Ohio	Development of intermediate an[illegible] scale wind systems and suppor[illegible]
Rocky Flats Plant Golden, Colorado	Development and testing of sma[illegible] systems and supporting studies.
Pacific Northwest Laboratory Richland, Washington	Wind resource research, site e[illegible] and wind characteristics suppo[illegible] design and operations.

U.S.A.

Windmill Specifications :

Electricity generating horizontal axis windmill.

	15 kw
Rotor diameter	14.6 m
No. of blades	2
Blade material	E-glass/epoxy
Shipping weight	1452 kg
Cut-in-wind speed	3.6 mt/sec
Cut-off-wind speed	35.8 mt/sec
Power output at a mt/sec	15 kw
Generator	Industion type
Tower height	50 ft
Tower weight	906 kg

80. * University of Alaska,
Arctic Environmental Information & Data Center,
707 A Street,
Anchorage, AK 88501,
U.S.A.

Contacts : James L. Wise, Tunis Wentink.

Activities :

Provide regional assessment for Alaska.

Budget :

FY $150,000 (for wind energy project).

Lead Laboratory :

Pacific Northwest Laboratory, Richland.

Funding Source :

DOE.

Publications :

Reports.

U.S.A.

81\. University of California,
Dept. of Material Science,
Hearst Mining Bldg.,
Berkeley, CA. 94720,
U.S.A.

Telephone : 415/642-3664; 415/845-WIND

Contact : M.F. Merriam, Associate Prof.

Activities :

Wind energy work commenced in 1972.
Specific activities are :
1) Extension/promotion.
2) Policy formulation/programme evaluation.
3) Education.

Publications :

Reviews and surveys, research papers.

Budget :

Variable.

Funding Source :

Variable.

82\. University of Colorado,
Austin Bluffs Pkwy.,
Colorado Springs, CO. 80907,
U.S.A.

Telephone : (303) 593-3164

Contact : Richard A. Blade, Prof. of Physics & Energy Science.

Activities :

Wind energy work commenced in 1980.
Main activities are :
1) Wind data collection and evaluation.
2) Education.

U.S.A.

Budget :

$38,000 for 2 years.

Funding Source :

National Science Foundation.

Windmill Installations :

Demonstration units of vertical axis windmill for power generation application.

83. * University of Dayton,
Research Institute,
300 College Park Avenue,
Dayton, OH. 45469,
U.S.A.

Contacts : Dale H. Whitford, John E. Minardi.

Activities :

1) Analysis of the Madaras Rotor Power Plants (100 MW to 200 MW range).
2) Research conducted on electrofluid dynamic (EFD) wind generator for power generation.

Funding Source :

DOE.

Lead Laboratory :

Solar Energy Research Institute, Colorado.

Publications :

Reports of above projects.

U.S.A.

84. University of Hawaii,
Dept. of Meteorology,
2325 Correa Road,
Honolulu, HI 96822,
U.S.A.

Contact : Colin S. Ramage, Principal Investigator,
Chairman Solar Energy Project.

Activities :

Wind data collection and evaluation: Produce regional assessment of wind data.

Budget :

$200,000 per annum.

Funding Source :

U.S. Department of Energy.

Publications :

Technical reports, reviews, surveys.

Personnel :

C.S. Ramage, P.A. Daniels and T.A. Schroeder.

85. * University of Michigan,
Radiation Laboratory,
Dept. of Electrical & Computer Engg.,
Ann Arbor, MI. 48109,
U.S.A.

Contact : Thomas B.A. Senior.

Activities :

Study of the electromagnetic interference by wind turbines.

Publication :

The WECS TV Siting Handbook.

U.S.A.

86. University of Minnesota,
Div. of Science & Maths,
Morris, MN. 56267,
U.S.A.

Telephone : 612-589-2211

Contact : Dr. A.A. Lopez, Associate Prof. of Maths & Director of Computer Center.

Activities :

Wind data collection and evaluation.

Budget :

About $10,000 per annum.

Funding Sources :

U.S. Community Services Administration.

Windmill Installations :

Type of installation : Demonstration unit and actu use type.
Type of windmill : Vertical axis and horizontal
Application : Power generation.

Personnel :

A.A. Lopez and Richard Burkey.

87. * University of New Mexico,
P.O. Box 188,
Albuquerque, NM. 87131,
U.S.A.

Contact : P.F. Lodde.

Activities :

Improving designs of Vertical Axis Wind Turbine foundation and guy anchors in order to minimize the cost.

Budget :

FY 1979 - $8,449 (wind energy project).

Lead Laboratory :

Sandia Laboratories, Albuquerque.

Fundin- Source :

DOE.

Publications :

Technical reports.

88. University of Oklahoma,
1928, Goddard,
Norman, OK. 73069,
U.S.A.
Telephone : (405) 325-7241

Contact : Prof. Karl H. Bergey.

Activities :

Research and development.

Windmill Installations :

Type of installation :	Laboratory scale and demonstration models.
Type of windmills :	Vertical axis and horizontal axis.
Application :	Power generation.

89. * University of Tennessee,
Dept. of Electrical Engg.,
Knoxville, Tennessee 37916,
U.S.A.

Contact : Thomas W. Reddoch.

Activities :

Review technical information of Dept. of Energy (DOE) contractors investigating wind machines and the utility interface.

Budget :

FY 1979 - $30,727 (wind energy project).

Fundin: Source :

DOE, Washington.

Publications :

Technical reports.

90. * University of Toledo,
Dept. of Mechanical Engg.,
2801 West Bancroft,
Toledo, Ohio 43606,
U.S.A.

Contact : D. Spera.

Activities :

Provides analytical support services to the NASA Wind Energy Project Office analytical group to enable them to carry out their supporting analysis (aeroelastic stability analysis services).

Budget :

FY 1979 - $133,000 (wind energy project).

Lead Agency :

NASA Lewis Research Center, Cleveland.

Funding Source :

DOE.

Publications :

Technical reports.

U.S.A.

91. * University of Virginia,
Charlottesville, VA. 22903,
U.S.A.

Contact : Michael Garstang.

Activities :

Work began in 1976, with a program to study the wind power potential of the U.S. East Coast and Gulf Coast regions (from Maine to Texas).

Budget :

FY 1979 - $95,000 (for wind energy project).

Lead Laboratory :

Pacific Northwest Laboratory, Richland.

Funding Source :

DOE.

Publications :

A report on the 1979 year's activity has been submitted.

92. * University of Wyoming,
Laramie, WY. 82071,
U.S.A.

Contact : R.W. Marrs.

Activities :

Wind characteristic study began in 1976. Determine the feasibility of identifying high wind sites from satellite imagery.

Lead Laboratory :

Pacific Northwest Laboratory, Richland.

Funding Source :

DOE.

U.S.A.

Publications :

A handbook has been prepared which describes procedures for interpreting wind characteristics from aeolian features.

93. Virginia Polytechnic Institute,
P.O. Box 60220,
Blackburg, VA. 24061,
U.S.A.

Contact : Dr. Joseph A. Schetz (Dept. of Aerospace & Ocean Engg.).

Activities :

Wind energy work commenced in 1975.
Main activities are :

1) R&D on aerodynamics, dynamics, structures and economics.
2) Developing reference documents for estimating atmospheric characteristics for WECS design.
3) Provide information on the practicality of using wind power for apple storage cooling (a 6kw wind turbine was installed for this purpose).

Budget :

$60,000 per annum.

Funding Source :

U.S. Dept. of Agriculture, Virginia.

Publications :

Technical reports, research papers.

Windmill Installations :

Full-scale and lab-models.

Personnel :

Dr. W. O'Brien, Dr. D. Vaughan, Dr. K. Sundkuist.

U.S.A.

94. **Volunteers in Technical Assistance,**
3706 Rhóde Island Ave.,
Mt. Rainier, MD. 20822,
U.S.A.

Telephone : 301-277-7000 Telegram : VITA INC
Telex : 440192 VITA U1

Contact : Henry Norman, Executive Director.
Alan Wyatt, Associate Technical Advisor.

Activities :

Work began in 1959.
Activities are :

1) Information dissemination to requestors worldwide (by mail).
2) On site consulting - worldwide.
3) Small grant funding of wind energy and other projects worldwide.
4) Publication of technical manuals.
5) Development of 2 prototype windmills - with Instituto de Investigationes Electricas (IIE) in Cuernevaca, Mexico.
6) In future, work envisaged, is, completion of design of prototype mills, testing, evaluation and possible licensing for production and marketing.

Funding Source :

U.S. Agency for International Development; U.S. Corporations (General Electric) and others.

Publications :

Books and monographs, technical reports, drawing, construction manuals of prototypes. Brochures on VITA documentation services, consultancy services, projects supported and volunteer opportunities.

Windmill Installations :

Horizontal axis windmill : In cooperation with IIE, Cuernevaca Mexico 2 windmill[illegible] are being developed :
1 sail wing water pumping [illegible] mill (design stage), 3 sails, 10 m diameter, rated to [illegible]

U.S.A.

60 US gallons/min at windspeeds of 12 mph, uses a variable strok mechanism, uses brass piston p for a deep well.
1 electric windmill (in initial design stage), capacity 10-12 kw

Personnel :

1 full time (Alan Wyatt) and 3 part time.

95. * Washington University Technology Association,
Dept. of Mechanical Engg.,
St. Louis, MO. 63130,
U.S.A.

Contact : K.H. Hohenemser.

Activities :

Generic study of sail wing wind energy systems.

Budget :

FY 1979 - $22,500 (wind energy project).

Lead Laboratory :

Solar Energy Research Institute, Colorado.

Funding Source :

DOE.

Publications :

Technical reports.

U.S.A.

96\. Water and Power Resources Service,
Advance Energy Applications,
Attn: Code D-150CE,
P.O. Box 25007,
Denver, CO. 80225,
U.S.A.

Telephone : (303)-234-6305
Telex : 45737 Answer back WPRS DVR

Telegram : Western Union Using [illegible] or RCA Inc.

Person-in-charge : Mr. Stanley J. Hightower, Coordinator.
Harley J. Warren, Chief, Engr. Services [illegible]

Activities :

- Wind data collection and evaluation.
- Research and development.
- Extension/promotion.
- Policy formulation/programme evaluation.
- Financing/supporting: Water Power Resources Services awarded a contract of $6 million to Hamilton Standard Co., of Windsor Locks, Connecticut for the construction of the world's largest capacity (4 mw) wind turbine generator.

Publications :

Technical reports, research papers.

Budget :

$615,000 for research on solar, wind and advanced hydro systems; $5,000,000 for Agency annually for specific projects in windpower.

Source :

U.S. Govt., Dept. of the Interior.

Windmill Installations :

Demonstration unit of horizontal axis windmill for power generation application.

Personnel :

Abner Watts, Larry Nelson and David Mayturn.

U.S.A.

97. Wave Propagation Laboratory,
NOAA/ERL U.S. Dept. of Commerce,
325, Broadway,
Boulder, CO. 80303,
U.S.A.

Telephone : 303-497-6263 Telex : 45897

Contact : Dr. Chandran Kaimal, Scientist, Boulder Atmospheric Observatory.

Activities :

Wind energy work commenced in 1979. Analysis of wind statistics for the design of wind turbine generators. Interpretation of statistics from two high-wind cases will continue into the next year (1981).

Budget :

About $80,000 per year.

Lead Laboratory :

Pacific Northwest Laboratory, Richland.

Funding Source :

DOE.

Publications :

Research papers (wind characteristics).

Personnel :

2 full time, 1 part time meteorologists.

98. * Weather Service Corp.,
Bedford, MA. 01730,
U.S.A.

Contact : J.P. Murphy.

U.S.A.

Activities :

Produce and evaluate subjective wind forecasts (for DOE candidate sites for 12 months).

Budget :

FY 1979 - $34,000 (wind energy project).

Lead Laboratory :

Pacific Northwest Laboratory, Richland.

Funding Source :

DOE.

Output :

Computer data tape of hourly wind speed forecast for a period of 12 months.

99. * Western Scientific Services, Inc.,
328, Airpark Drive,
P.O. Box 965,
Ft. Collins, CO. 80522,
U.S.A.

Contact : J.R. Connell.

Activities :

Characterizing wind at singular topographic features such as mountains or ridges.

Budget :

FY 1979 - $44,000 (wind energy project).

Lead Laboratory :

Pacific Northwest Laboratory, Richland.

Funding Source :

DOE.

U.S.A.

Publications :

Technical reports (wind characteristics), guides.

100. West Indies Laboratory,
Fairleigh Dickinson University,
P.O. Box 4010,
Christiansted, St. Croix,
Virgin Islands 00820,
U.S.A.

Telephone : (809) 773-3339.

Contact : Robert F. Dill, Director.

Activities :

Wind data collection and evaluation, wind research and development (wind energy conversion systems).

Funding Source :

National Oceanic Atmospheric Administration.

101. * West Virginia University,
Morgantown, WV. 26506,
U.S.A.

Contact : Richard E. Walters.

Activities :

Research and development : Innovative wind turbines.

Funding Source :

DOE, Wind System Branch, Washington.

U.S.A.

102. Wichita State University,
Wind Energy Laboratory,
Wichita, KS. 67208,
U.S.A.

Telephone : 316-689-3415

Contact : Gary C. Thomann.

Activities :

Work commenced in 1973.
Main activity is :
Research and development: Analysis and conceptual design of spoiler (blade) control for Large Wind Turbine Generators (tested on MOD-0, 100 kw wind turbine).

Publications :

Technical reports.

Budget :

$200,000 per annum.

Funding Source :

State of Kansas; Dept. of Energy.

Windmill Installations :

Demonstration units of horizontal axis windmill for power generation application.

COMMERCIAL MANUFACTURERS

- instruments
- wind electric generators
- water pumping windmills
- subsystem & components (blades, towers).

INSTRUMENTS

1. * Belfort Instrument Co.,
   1600 S Clinton Street,
   Baltimore, Maryland 21224,
   U.S.A.

   Telephone : 301-342-2626 Cable : BELF

   Contact : J. B. Reilly, President.

   Products Manufactured :

   Wind transmitters, wind indicators, recorders, wind alarm, anemometer, wind measuring sets.

   Publications :

   A catalogue of Belfort Instrument Co., which contains complete technical information like specifications, ordering information, detailed drawings and catalogue number of the product. Also a Domestic Price List is available.

2. * Climent Instruments Co.,
   1320, West Colton Avenue,
   Redlands, CA. 92373,
   U.S.A.

   Products Manufactured :

   Wind direction indicators, anemometers.

Instruments

3. * Dwyer Instruments, Inc.,
Jet Ind. 212 & US 12,
Michigan City, IN. 46360,
U.S.A.

Products :

Anemometers, wind direction indicator.

4. * Elgar Corporation
8225 Mercury Cart,
San Diego, CA. 92111,
U.S.A.

Products :

Utility interface/inverters.

5. * Georator Corp.,
P.O. Box 70,
9617 Center St.,
Manassas, Virginia 22110,
U.S.A.

Products :

Brushless permanent magnet alternator.

6. * Hy-Cal Engineering,
12105 Los Nietos Road,
Santa Fe Springs, CA. 90670,
U.S.A.

Products :

Anemometers.

Instruments

7. * Kahl Scientific Instrument Corporation,
737, West Main Street,
El Cajon, CA. 92022,
U.S.A.

Products :

Anemometers.

8. Lund Enterprises, Inc.,
1180 Industrial Avenue,
Escondido, CA. 92925,
U.S.A.

Telephone : 714-746-1211

Product :

WINDFLOWER Windcomputer.

Publication :

Brochure with product information.

Product Description :

Windflower Windcomputer computes the production of a windgenerator at any given length of time. It works with batteries charged by sunlight. It also functions as an anemometer.

9. * M.C. Stewart Co.,
Crosby Road,
Ashburnham, MA. 01430,
U.S.A.

Products :

Anemometers, data aquisition systems.

Instruments

10.* Meteorology Research, Inc.,
464, West Woodbury Road,
Altadena, CA. 91001,
U.S.A.

Products :

Anemometers, wind direction indicator, data acquisition systems.

11. Natural Power, Inc.,
Francestown Turnpike,
New Boston, New Hampshire 03070,
U.S.A.

Telephone : 603-487-5512 Telex : Jastern Jenk #845233

Contact : Richard Katzenberg, President.
Deborra A. Doscher, Export Marketing Coordinator.

Activities :

Founded in 1972, with current activities of designing, manufacturing and marketing of products for the renewable energy industry.

Products :

Several models of the following :

Wind Site Analysis Equipments :

Wind Data Accumalator, Wind Recording Instruments, Real Time Data Logger (magnetic tape recorder), Wind Speed Compilator.

Wind Energy Conversion Systems Instruments :

Controls, Alternators, Monitors.

Publications :

Current product catalogue (with detailed specifications of each model); export product list.

12.* R.M. Young Co.,
2801 Aero Park Drive,
Traverse City, MI. 49684,
U.S.A.

Product :

Anemometer.

13.* Real Gas & Electric Co.,
P.O. Box F,
278, Barham Ave.,
Santa Rose, CA. 95402,
U.S.A.

Products :

Utility interface/inverter.

14.* Soleq Corp.,
5969, North Elston Ave.,
Chicago, IL. 60646,
U.S.A.

Products :

Utility interface/inverters.

15.* Teledyne Geotech,
3401 Shiloh Road,
Garland, TX. 75041,
U.S.A.

Products :

Anemometers, wind direction indicators.

Instruments

16.*Texas Electronics, Inc.,
5529 Redfield Street,
P.O. Box 7225,
Dallas, TX. 75235,
U.S.A.

Products :

Wind direction indicators, anemometers, data aquisition systems.

17.*Weathertronics, Inc.,
2777 Del Monte St.,
West Sacramento, CA. 95691,
U.S.A.

Products :

Wind direction indicators, anemometers, data aquisition systems.

18.*Winfred M. Berg, Inc.,
499, Ocean Ave.,
East Rockaway, Long Island,
N.Y. 11518,
U.S.A.

Products :

Wind machine, transmissions.

WIND ELECTRIC GENERATORS

1.* Aerolectric Co.,
13517 Winter Lane.
Cresaptown, MD. 21502,
U.S.A.

Products :

Tri-blade, wind machines.

2. * AERO Power Systems,
2398 Fourth St.,
Berkeley, CA. 94710,
U.S.A.

Telephone : 415-848-2710

Products :

Small wind turbine generator systems; towers; tri-blade wind machines; wind turbine blades.

Windmill Specifications :

Aero Power's Starlite (SL) wind power systems employ a high torque drive system to reduce noise, maintenance and cost. All units are fully automatic, upwind, horizontal axis machines with a centrifugally activated feathering hub and 10 ft or 12 ft propellers. The model SL 1000 is rated at 1 kw at 22 mph wind speed; the SL 1500 is rated at 1.5 kw in a 22 mph wind. System is available in 14 and 28 VD6 output. Aero Power also offers the SL 1500 utility interface system with 100 V AC output.

3.* All American Engg. Co.,
801, South Madison St.,
Wilmington, DE. 19899,
U.S.A.

Product :

Windmill systems

Wind Electric Generators

4. * Alstham-Neyrpictechniques des Fluides,
B.P. 75,
38041 Grenoble Cedex,
FRANCE.

Product :

Electricity generating windmill.

5. * Aidco Maine Corp.,
Orr's Island, ME. 04066,
U.S.A.

Products :

Wind turbine, generator systems.

6. * American Energy Alternatives,
P.O. Box 905,
Boulder, CO. 80302,
U.S.A.

Contact : John Sayler.

Products :

Multi-blades, wind machines.

7. * American Wind Turbine, Inc.,
1016, East Airport Road,
Stillwater, OK. 74074;
U.S.A.

Products :

Multi blade, wind machines.

Wind Electric Generators

8.* Alfred Christensen,
Kuriant, Industriarealet 54-60,
DK-6990 Ulfborg,
Denmark.

Telephone : (07) 491666

Product :

Electricity generating windmill.

9. * Astral Wilcon,
P.O. Box 291,
Milbury, MA. 01527,
U.S.A.

Telephone : 617/86

Products :

Wind generator. Manufacture custom rotor blades for other systems.

Windmill Specifications :

Model :	AW 10-B
Rotor diameter :	8 mt
No. of blades :	3
Governing :	Automatic pitch
Output :	10 kw
Generator :	3 phase brushless alternator. Synchronous inverter.
Tower :	40 feet

10.* Automatic Power, Inc.,
213, Hutcheson St.,
Houston, TX. 77023,
U.S.A.

Products :

Wind machine generators; dual blade wind machines; towers; wind turbine blades.

11. Bergey Windpower Co.,
2001 Priestley Ave.,
Norman, OK. 73069,
U.S.A.

Telephone : 405-364-4212

Contact : Karl Bergey, President.

Activities :

Designing and testing of wind power generators, designing of both horizontal axis and vertical-axis machines, application of aircraft design experience to the wind power field.

Products :

Windpower generators, inverter.

Publications :

Brochures.

Windmill Specifications : (Electricity generating windmill)

Models :	BWC 650 and BWC 1000
Rotor diameter	2.6 mt
No. of blades	3
Blade material	all-metal
Survival windspeed :	120 miles per hour
Maximum output :	650 W, 1000 W
Generator : DC	12 V, 24 V, 36 V, 48 V, 120 V.

Special Features :

1) The BWC incorporates a low-speed permanent magnet alternator driven directly by the rotor.
2) The BWC POWERFLEX^{Tm} rotor system provides variable pitch performance.
3) AUTOFURL^{Tm} (tail) provides overspeed protection.
4) BWC EMS-4 controller is a complete battery management system.

Wind Electric Generators

12.* Val O. Bertoia,
Bertoia Studio,
644 Main St.,
Bally, PA. 19503,
U.S.A.

Products :

Electrical wind machines.

13.* DAF (Dominium Aluminium Fabricating),
3570 Hawkestone Road,
Mississauga, Ontario,
Canada L56 2V8.

Products :

Electricity generating windmills.

14. Dakota Wind & Sun Ltd.,
P.O. Box 178,
Aberdeen, SD. 57401,
U.S.A.
Telephone : 605-229-0815

Publications :

'The Dakota Wind Book' published by Living Energy Consultants Ltd., Colorado.

Products :

Small wind turbine generator systems (electricity generating). Dakota Wind & Sun Ltd., are manufacturers of LYNNER Wind electric machines.

Specifications :

Type :	Horizontal axis, upwind.
Rotor diameter :	4.3 mt
No. of blades	3
Blade material :	Wood, epoxy paint.
Transmission ratio	270

Wind Electric Generators

Cut-in-wind speed :	3.5 mt/sec.
Cut-out-wind speed :	18 mt/sec.
Governing :	Centrifugal blade featherin[illegible]
Maximum output at 12 m/s	4000 W
Generator	110 V, DC 3 phase alternator

Dakota's five models have output of 2.2, 4.5, 7.5, 15 and 200 kw.

15. Dansk Vindkraft Industri Aps,
Vendevej 6, Bureso,
DK-3550, Slangerup,
Denmark.

Telephone : 452-1834 39

Product :

Vertical axis Voight Schneider (Giromill).

Publications :

Specification brochure.

Windmill Specifications : Electricity Generating Giromill

Model :	DVI 15/2
No. of blades :	3
Blade material :	Aluminum
Rotor diameter :	9 mt
Governing :	Airbrakes activated by cen[illegible] fugal forces.
Transmission :	Gear.
Generator :	AC alternator, 15 kw, 3 ph[illegible] 380/220V.
Output at 15 mt/sec :	14.2 kw.
Tower :	Steel types.
Tower Height :	9.95 m or higher.

Wind Electric Generators

16. Dansk Vindmollefabrik Aps,
Ove Rasmussen,
Strandholtvej 24, Skellerup,
DK-9500 Mobro,
Denmark.

Products :

Electricity generating wind machines.

17. * Dragonfly Wind Electric,
P.O. Box 1781,
811 First Ave.,
N.W. Aberdeen, SD. 57401,
U.S.A.

Telephone : 707-937-4710

Products :

Do-it-yourself kits.

Product Information :

Dragonfly wind elec
in do-it-yourself kits. Complete kits feature tilt axis overspeed protection, four to one V-belt pulley transmission, automotive alternator or generator, 8 ft. diameter redwood blades and a three year warranty.

18. Dunlite,
Manufacturing & Export Div.,
28, Orsmond St.,
P.O. Box 100, Hindmarsh,
South Australia 5007.

Telephone : (08) 46 3832 Telegram : DUNLITE
Telex : AA82893

Contact : I.L. Besly, General Manager.

Wind Electric Generators

Activities :

40 years experience in power generation. At present, the firm is a leading wind electric generator manufacturer of Australia. Main activities are research and development (wind-powered generating systems); production and marketing (wind driven generating equipments).

Publications :

Publicity brochures (specifications, illustrations) books and monographs, manual on 'Planning a wind powered generating system.'

Windmill Specifications: (Electricity generating windmill Horizontal axis, tri blade)

Model :	2000 W	5000 W
Rotor diameter :	2.7 mt	5.6 mt
No. of blades :	3	3
Blade material :	Stainless steel	Stainless steel
Cut-in-windspeed :	4.4 mt/sec	3 mt/sec
Cut-off-windspeed :	11 mt/sec	9.37 mt/sec
Transmission :	Gear	Gear
Transmission ratio :	5:1	5:1
Governing :	Automatically controlled by centrifugal governor.	
Power output :	2000 W	5000 W
Generator : DC	3 phase, brushless alternator	
Voltage output :	24, 32, 110V	110 V
Tower :	3 legged, steel braced, galvanized in various heights.	

Wind Electric Generators (Contd.)

19. Dyenergy Corp.,
P.O. Box 428,
1269 Union Ave.,
Laconia, N.H. 03246,
U.S.A.
Telephone : 603-524-8313

Person in-charge : Dick Masters, Production Manager.
Ed Mallett, Marketing Manager.

Activities :

Site analysis, research and development (under DOE program the first installation of a Dyenergy wind turbine will be in Brownsville, Texas), production and marketing of vertical axis wind turbines.

Products

Darrieus rotors; small wind turbine generator systems; utility interface/inverters; wind machine alternators; wind machine generators.

Publications :

Article in New Hampsire Times (V. 9 No. 44, 1980); publicity brochures, specification sheets, photos, technical reports, research papers, reviews.

Windmill Specifications : (Electricity generating windmills)

Turbine type : Vertical Axis Darrieus
Rotor diameter : 4.6 mt
No. of blades : 3
Blade material : Aluminium 6061-T6
Weight rotor : 140 kg

Weight System
(a) Wind turbine alone : 360 kg
(b) With alternator and starter : 480 kg
(c) With dual induction generator-starter : 448 kg

Operational wind velocity : 4.4 mt/sec to 17.8 mt/sec
Governing : disc brake aerodynamic stall
Power output at 10.7 mt/sec : 330 W

Wind Electric Generators

20. Elektro GmbH,
St. Gallerstrasse 27,
CH-8400 Winterthur,
Schweiz,
Switzerland.

Telephone : 052/22 34 34 Telex · 76299 Electro

Products :

Anemometer; wind driven generators (ranging from 50 W to 10 kw) for tropical or artic regions

Publications :

Product Specification sheets and brochures. A manual '37 years experience with Elektro Windmills' is available from the company.

Windmill Specifications :

Rotor diameter	.75 x 1	.66 x 1.3	2.5	3.5	3.8	5.0
No. of blades	6	6	2	3	3	3
Blade material		wood and metal blades				
Transmission		gear wheels				
Cut-in-windspeed				3m/s	3m/s	3m/s
Cut-off-windspeed	1-27m/s			20-23 m/s		
Governing		centrifugal force				
Power output	50 W	150 W	500 W	2000 W	2000 W	5000 W
Voltage (V)	6/12/24	12/24/36	24/36/48	36/35/ 110	36/35/ 110	65/110
Also :						
Rotor diameter	3	3.6	4.4	5	6	
No. of blades	2	2	3	3	3	
Weights (kg)	135	180	235	265	315	
Power output	1200 W	2000 W	3500 W	5000 W	8000 W	
Voltage	24/36 48	36/38 110/90	48/60 110/125 220	60/110 125/226	110/125	

Wind Electric Generators

21.* Enag,
Route de Part l'Abbe,
2900 Quimper,
France.

Product :

Electricity generating windmill.

22.* Energy Development Co.,
179, East Road 2,
Hamburg, PA. 19526,
U.S.A.

Products :

Large WTG System; multi blade wind machines.

23. * Environmental Energies, Inc.,
Front Street, Copemish,
MI. 49625,
U.S.A.
Telephone : 616-378-2000

Product :

Wind Turbine Generator Systems.

Windmill Specifications :

Environmental Energies' Helical Wind Turbine features a high torque, slow speed Helical Airfoil developed for low to moderate wind characteristics. The newly patented horizontal axis wind madhine employs 4-blade sets spaced in-depth and indexed helically. The bub assembly is self-governing, requiring no feathering mechanism; the generator is manufactured by general.

Wind Electric Generators

24. * Erini Maskinfabrik,
Fynsgrade,
DK-7400, Herning,
Denmark.

Products :

Electricity generating wind machines.

25. * Flanagan's Plans, Inc.,
Front St., Copemish,
MI. 49625,
U.S.A.

Products :

Small WTG Systems; wind energy subsystems.

26. * General Electric Co.,
Space Division,
P.O. Box 13601,
Philadelphia, PA. 19101,
U.S.A.

Product :

Large wind turbine generator systems.

27. * Grumman Energy Systems,
4175 Veterans Memorial Highway,
Ronkonkoma, N.Y. 11714,
U.S.A.

Products :

Tri blade wind machines; small wind turbine generator systems.

Wind Electric Generators

28.* Hamilton Standard,
Windsor Locks,
CT. 06906,
U.S.A.

Products :
Large wind turbine generator systems.

29. * Helleskov Maskinvaerksted,
Henrik Stiesdal,
Helleskovvej 4, DK-7480,
Vildbjerg,
Denmark.
Telephone : (07) 131355

Product :
Electricity generating windmills.

30. * Henry Jorgensen,
Solhoj, Sejruip,
DK-Give,
Denmark
Telephone : (05) 734384

Product :
Electricity generating wind machines.

31.* Herborg Vindkraft,
Oster Herborguej 4,
DK-6920 Videback,
Denmark.
Telephone : (07) 171877

Product :
Electricity generating wind machines.

Wind Electric Generators

32. *' Hermann Brummer Wind Kraftanlagen KG,
3522 Bad Karlshafen 2-Helmarshaugen,
Muhlenstrasse 1-6,
West Germany.

Products :

Electricity generating windmills.

33. * Hinton Research & Development Corp.,
417, Kensington,
Salt Lake City, UT. 84115,
U.S.A.

Telephone : 801-487-3896

Windmill Specifications :

Hinton's 3 kw wind turbine generator has an 11' diameter 2-blade propeller on a horizontal axis. Blades are manufactured by compression molded epoxy fiberglass over a polyurethane core. Two small centrifugally-operated governing blades provide rpm control. An oil bath gear box connects a 12 pole synchronous alternator. Output is 48 or 120 VDC. An optical inverter produces 60 cycles a-c power or operates in parallel with the utility system.

34. Independent Energy Systems, Inc.,
6043 Sterreltania Rd.,
Fairview, PA. 16415,
U.S.A.

Telephone : 814-833-3567

Activities :

Site analysis, installation and service on all products, replacement parts for old Jacob Wind Plants, installation supervisors provided for wind systems anywhere in the world, manufacturing and selling wind machines.

Wind Electric Generators

Products :

Anemometers; small wind turbine generators; towers; tri blade wind machines; utility interface/ inverters; wind direction indicators.

Publications :

'Independent Energy Systems, Inc., Catalog #217', data sheets, brochures.

Windmill Specifications : (Electricity generating windmill)

Model	SKY HAWK II	SKY HAWK IV
Rotor diameter	4.12 mt	4.57 mt
No. of blades	3	3
Blade material	aircraft quality Sitka Spruce	
System weight	220 kg	272 kg
Cut-in-windspeed	3.1 mt/sec	3.1 mt/se
Cut-off-windspeed	22.4 mt/sec	22.4 mt/s
Governing	Centrifugally activated blade pit	
Max. output at 12.1 mt/ sec.	2000 W	4000 W
Generator	140 V, DC	

Following windmill systems using the 4 kw Sky Hawk generator are sold by Independent Energy, Inc.

1) System 770 DC/AC
2) System 780 DC/AC
3) System 781 DC only
4) System 782 DC/DC Back-up generator
5) System 783 AC/Supplementary (recommended for electric-heated homes, large operations, etc.)
6) System 784 AC/Power Failure back-up
7) System 785 AC/Battery emergency back-up
8) System 786 DC/Hot water heating

35. * Jacobs Wind Electric Co., Inc.,
Route 13, Box 722,
Fort Myers, FL. 33908,
U.S.A.
Telephone : 813-481-3113

Windmill Specifications :

Jacobs' new kilovolt-ampere wind energy system features variable pitch propeller speed control and completely automatic voltage and charging regulation. The 3-blade, horizontal axis unit has a hypoid gear drive inclined upward 10°. Other features include brushless alternator mounted in a special 6 ft top tower section; patented blade actuated governor; and storm protection control.

36. Jay Carter Enterprise,
P.O. Box 684,
Burkburnett, Texas 76354,
U.S.A.

Telephone : 817-569-2238

Product :

Wind generators.

Publications :

Coloured brochure which includes technical information of the windmill with picture illustrations and graphs.

Windmill Specifications :

Model : JCE Model 25 (Horizontal axis, electricity generating)

Rotor diameter :	9,57 m
No. of blades :	2
Blade material :	Fiberglass and PVC foam with a continuous filament wound spar
Transmission :	Gears
Governing :	Automatic

Output :
Rated output at 12.4 mt/sec : 25 kw
Maximum output at 13-18 mt/sec : 30 kw

Generator :	Single or 3-phase, 220 or 4410 Volts. 60 cycle AC current.
Tower :	60 feet high galvanized pole supported with 4 guy wires.

Wind Electric Generators

37. Kaman Aerospace Corp.,
Old Windsor Road,
Bloomfield, Connecticut 06002,
U.S.A.

Telephone : 203-242-4461

Contact : William R. Batesole, Manager - Wind Energy Program

Activities :

Wind energy work commenced in 1974.
Main activities are research and development (development of a 40 kw horizontal axis wind turbine generator; development of composite blades for large wind turbines); production and marketing (production units of 40 kw planned in early 1982).

Publications :

Reports, research papers, books, monographs, specification sheets.

Windmill Specifications : (40 kw electricity generating windmill in prototype phase)

Rotor type :	horizontal axis, down wind.
Rotor diameter :	19.5 mt
No. of blades :	2
Blade material :	Fiberglass
Cut-in-windspeed (mt/sec) :	10
Cut-off-windspeed (mt/sec) :	60
Rated output at 9 mt/sec :	40 kw
Generator :	AC 48 V
Tower :	3 steel, tube legs, self supporting
Applications :	Deep well irrigation pumping and providing power to small isolated communities and small factories.

Budget :

Variable.

Wind Electric Generators

Fundin: Source :

U.S. Dept. of Energy.

Personnel :

Approx. 75.
B.A. Goodale, Manager, Wind Energy Marketing.
A.Z. Lemnios, Director, Research & Technology.
H.E. Howes, Programme Manager, 40 kw Wind Turbine.
R. Perley, Manager, Systems integration.
L.C. Schuler, Vice President-Engg.
D.W. Robinson, Vice President - Planning & Marketing.

38. Kedco, Inc.,
9016, Aviation Boulevard,
Inglewood, CA. 90301,
U.S.A.
Telephone : 213-776-6636

Products :

Small wind turbine generator systems; tri blade wind machines; utility interface/inverters.

Publications :

Specifications sheets. Information guidelines on site survey, systems, references and other pertinent information on wind energy systems also available from the manufacturer.

Windmill Specifications : (Electricity Generating Windmills)

1200	1600	1205	1605	1210	1610	1620	1
3.7 mt	4.9 mt	3.7 mt	4.9 mt	3.7 mt	4.9mt	4.9mt	[illegible]
3	3	3	3	3	3	3	[illegible]
Aluminium blades / aerospace construction							
Gear drive							
2.7 - 4.0 mt/sec				4.0 - 5.4 mt/sec			
Automatic blade feathering by mechanical control							
9.5	7.2	11.2	8.9	11.2	9.8	11.2	
1200W	1200W	1900W	1900W	20 [illegible]W	2000W	3000 W	

Wind Electric Generators

Models	1200	1600	1205	1605	1210	1610	1620	1648
Generator	12V, DC	12V DC	24V DC	24V DC	variable 180V DC max	variable 180V DC max	vari-able 180V DC max	48V DC

39. Lubing Maschinenfabrik,
Postfach 110,
D-2847 Barnstorf,
Federal Republic of Germany.

Telephone: (05442) 625, 626, 627 Telex: 09-41212 lubig

Contact : K. Meyer, Sales Manager.

Products :

Wind generator, wind pumps.

Publications :

Information sheets about LUBIG - windpower plants.

Windmill Specifications : Electricity Generating Windmill

Rotor diameter :	2.2 mt.
No. of blades :	3 big + 3 small ones.
Blade material :	Blades epoxy resins with glass fibers.
Cut-in-windspeed :	3.5-4 mt/sec.
Governing :	Centrifugal.
Power output at 6 mt/sec :	220 W.
Generator :	24V DC.
Tower material :	Aluminium.
Tower height :	Various.

40.* McDonnell Douglas Energy Program,
5301, Bolsa Avenue,
Huntington Beach, CA. 92647,
U.S.A.

Product :

Vertical axis wind machines.

Wind Electric Generators

41. * McKim Solar Energies, Inc.,
1142, East 64th St.,
Tulsa, OK. 74136,
U.S.A.

Product :
Wind turbine generator systems.

42. * Megatech Corp.,
29, Cook St.,
Billerica, MA. 01866,
U.S.A.

Product :
Small wind turbine generator systems.

43. * Mehrkam Energy Development Co.,
Box 179-E, R.D. 2,
Hamburg, PA. 19526,
U.S.A.

Products :
Multi blade wind machines; large wind turbine.
generator systems.

44. * Millville Windmills, Inc.,
P.O. Box 32,
10335 Old Drive,
Millville, CA. 96062,
U.S.A.
Telephone : 916-547-4302

Publications :
Brochure: Catch the Wind (illustrated, specifications, graph).

Wind Electric Generators

Products :

Tri -blade electricity generating wind machines.

Windmill Specifications : (Horizontal axis, propeller type, 3 blade)

	10 kw
Rotor diameter :	7.6 mt
No. of blades :	3
Materials :	Aluminium & stainless steel
Transmission :	Gear wheel.
Transmission ratio :	24:1
Cut-in-speed :	4 mt/sec
Cut-out-speed :	27 mt/sec
Power output at 7 mt/sec	2500 W
11 mt/sec :	10 kw
Generator :	115 - 230V, AC
Tower height (mt) :	12,2 18,3 24,4 30,5

45. Noah Energie Systeme GmbH,
Gelsdorferstr 16,
D53, Bonn 1,
West Germany.
Telephone : 02221 61 37 12

Product :

Wind generators.

Publications :

Specification sheets in German.

Windmill Specifications : Electricity Generating Windmills

Rotor diameter :	6 mt	12 mt	12 mt	16 mt
No. of blades :	3 or 4	3	6	3
Transmission :	Direct-drive			
Power output at 7 mt/s	2 kw	15 kw	30 kw	45 kw
Generator :	Various upto 380 V			

Wind Electric Generators

46. Northwind Power Co.,
Box 315,
Warren, Vermount 05674,
U.S.A.,
Telephone : 802-496-2955   Telex : 94093 NORTHWIND WARV

Contact : John Norton, President.
Philip E. Tonks, Sales Director.

Activities :

Production and marketing, site and feasibility analysis, complete installation, maintenance service and training of operating personnel and field support.

Products :

Small wind turbine generator system; tri blade wind machines; utility interface/inverters.

Publications :

Brochure, technical reports.

Windmill Specifications : (Electricity generating windmill)

MODEL	Eagle II	Eagle III	HR2
Rotor diameter (mt) :	4,27	4,27	5
No. of blades :	3	3	3
Blade material :	-	-	Aircraft grade Sitka spruce
Transmission :	Direct	Drive	
Cut-in-windspeed (mt/sec) :	3,6	4,5	3,6
Cut-out-windspeed (mt/sec) :	9,8	11,2	4,7
Overspeed control :	-	Variable Axis Rotor control system (VARC)	
Governing :	blade feathering		
Maximum power output :	2 kw	3 kw	2200 W at 9 mt/sec
Generator DC :	32V, 110V	32V, 110V	synchronous alternator
Tower height :	18 mt	18 m	12 mt

Wind Electric Generators

Applications : Rural and remote applications such as repeater and seismic monitoring stations, offshore navigation aids and remote cabins and houses.

47. * O & K Hansen,
Egebjerggard,
Gammel Gang 2,
Kongsted,
DK-4292 Dianalund,
Denmark.

Telephone : (03) 560213

Product :

Electricity generating windmills.

48.* Pinson Energy Corp.,
P.O. Box 7,
Marstons, Mill, Mass. 02648,
U.S.A.

Product :

Vertical axis wind machines.

49. * Power Group International,
Suite 106,
13315 Stuebner-Airline Rd.,
Houston, TX. 77014,
U.S.A.

Telephone : 713-444-5000

Product :

Wind generators.

Wind Electric Generators

Windmill Specifications :

Model :	Humming Bird 4000/22
Type :	Upwind, horizontal axis
Rotor diameter :	4.26 mt
No. of blades :	3
Cut-in-speed :	3.1 mt/sec
Output at 9.8 mt/sec :	4 kw
Applications :	Model 4000/22. Remote is designed to charge battery banks in remote locations such as offshore platforms. Model 4000/22 Utility Tie-In interfaces directly with a utility line without an inverter.

50.* Repair Works,
Taipower Co.,
61 Yuh-Cheng Street,
Nan-kong, Taipei,
Taiwan.

Product :

Electricity generating windmill.

51.* Riisagermollen,
Oxholm, Oland,
DK-9460 Brovst,
Denmark.

Telephone : (08) 236005

Product :

Electricity generating windmills.

Wind Electric Generators

52.* S.J. Wind Power Aps,
Suderbonej 4,
DK-9900, Frederikshaven,
Denmark.

Product :

Electricity generating windmills.

53.* Selectromarine,
Ralph Howe Marketing Ltd.,
New Orchard & High Street,
Poole Dorset,
England.

Product :

Electricity generating windmill.

54. Sencenbaugh Wind Electric,
253, Polaris Ave.,
Mt. View, CA. 94040,
U.S.A.

Telephone : 415-964-1593

Contact : James Sencenbaugh.

Activities :

Wind data collection and evaluation, research and development, production and marketing.

Publications :

Specification sheets, price lists.

Products :

Anemometers; power conditioning equipment; tri-blade wind machine; wind turbine blades.

Wind Electric Generators

Windmill Specifications : (Electricity generating windmills)

Model	24-14	500-14	500-14HDS	1000-14
Rotor diameter	0,51	1,83	1,98	3,66
No. of blades	3	3	3	3
Blade materials	st. steel aluminium p. urethaan	aluminium	aluminium	aluminiur
Transmission	direct	direct	direct	gear
Transmission ratio	-	-	-	3:1
Weight rotor (kg)	8,2	110	36,3	138
Cut-in-speed (mt/ sec)	3,6	4,4	3,9	3,3
Max. windspeed (mt/sec)	44	65	65	35
Power output	24 W	500 W	500 W	1000 W
Generator	12V,DC	12,24V DC	12V DC	12,24V D

Other Models

No.	Description
Sencenbaugh 1000-28	1000 watt, 24V DC
" 1800-28	1800 watt, 24V DC
" 500-28	500 watt, 12V DC

55. * Sonebjerg Maskinfabrik A/s,
Sonebjerg,
DK-6000 Kolding,
Denmark.
Telephone : (05) 522799

Product :

Electricity generating windmills.

56. * Sunflower Power, Rt. 1 Box,
93-A, Oskaloosa, Kansas 66066,
U.S.A.

Product :

Electricity generating windmills.

Wind Electric Generators

57. Trimble Windmills,
55, East Parade,
Harrogate, North Yorkshire HG1 5LQ,
U.K.

Telephone : 0423 501146

Contact : Andrew Stobart, Director, Trimble's Windmill Limited.

Product :

Multi blade wind machine.

Publications :

Timblemill specification leaflet.

Windmill Specification :

Type : Multiblade horizontal axis, electricity generating windmill.

Rotor diameter :	6 m
Blades :	Sail type
Blade material :	aluminium frame with terylene sail cloth
Tower :	ductile iron unitary construction for corrosion resistance
Output :	
At windspeed 10 mt/sec :	5 kw
At windspeed 23.6 mt/sec :	12.5 kw
Generator :	AC, 240 V
Applications :	Timblemill is designed primarily to provide heating for domestic or agricultural premises. This heating can be done by hot water via a central heating system into which the Trimblemill is connected, or by hot air using a "night storage" type of heater which is supplied with Trimblemill.

Wind Electric Generators

58. * Tumac Industries, Inc.,
650 Ford St.,
Colorado Springs, CO. 80915,
U.S.A.

Telephone : 303-596-4400

Product :

Darrieus wind turbine.

Windmill Specifications :

Tumac's 7 by 5 meters Darrieus wind turbine features 2-speed operation; 1 or 3 phase induction generators; synchronized and matched power in volts with utility power; a microcomputer control system and brake protection. The blades are extruded aluminum;output is 1.5 kw at 17.5 mph to 6.8 kw at 31 mph.

59. * Ulrik Poulsen,
Innoventic Aps,
Strandvejen 666,
DK-2930, Klampenborg,
Denmark.

Telephone : (01) 636566

Product :

Electricity generating wind machine.

60.* Vendelbo Trapper,
Arne Brogard,
Golstrup Hede 93,
DK-9480 Lokken,
Denmark.

Telephone : (08) 996244

Wind Electric Generators

Product :

Windmill producing electrical power for water heating.

61.* Volund A/s,
Marsk Stigsvej 4,
DK-9000 Alborg,
Denmark.

Telephone : (08) 139215

Product :

Electricity generating windmills.

62.* Walder Manufacturing Co.,
Route 2, P.O. Box 76,
Galena, KS. 66739,
U.S.A.

Product :

Savonius rotors.

63. Westinghouse Electric Corp.,
Industry Service Div.,
875, Greentree Road,
Building No. 8, Fourth Floor,
Pittsburgh, Pennsylvania 15220,
U.S.A.

Telephone : 412-928-2430

Contact : W.E. Treese, Project Manager, Wind Energy System.

Activities :

Currently engaged in 200 kw rated units built in conjunction with DOE and NASA. Future designs are rated at 500 kw and up through 750 kw.

Wind Electric Generators

Publications :

Descriptive bulletin : Wind Turbine Generators : Harvest the wind for energy, specification sheets.

Product :

Large wind turbine genarating systems.

Windmill Specifications : Electricity generating windmills

	200 kw	500 kw
Rotor diameter	38.1 mt	38.1 mt
Speed	40 rpm	42 rpm
No. of blades	2	2
Material	Aluminium	Wood
Transmission ratio	45:1	42.86:1
Cut-in-windspeed (at hub)	5 mt/sec	6.3 mt/sec
Cut-off-windspeed (at hub)	17.9 mt/sec	22.4 mt/se
Power output	200 kw	500 kw
Generator	AC 480 V	AC 4160
Tower		
Type	Pipe truss	Pipe truss
Height	93 ft	93 ft

64.* Whirlwind Power Co.,
2458, West 29th Avenue,
Denver, CO. 80211,
U.S.A.

Products :

Dual-blade wind machines; small WTG system; wind turbine blades.

65. Winco Div. of Dyna Technology,
7850 Metro Parkway,
Minneapolis, MN. 55420,
U.S.A.

Telephone : 612-853-8400

Contact : Len Attema, VP Marketing.

Wind Electric Generators

Activities :

Research and development; production and marketing, extension/promotion.

Publications :

Specification sheets, photographs, technical manuals, brochures.

Products :

Dual-bladed wind machines; small wind turbine generator system; wind driven battery charges (name WINCHARGER).

Windmill Specifications : (Electricity generating windmill)

Rotor diameter	1.8 mt
No. of blades	2
Blade material	wood
Cut-in-speed	3 mt/sec
Cut-off-speed	30 mt/sec
Governing	air brake centrifugally activated
Maximum power output at 10 mt/sec	200 W
Weight system	60 kg
Tower material	steel
Tower height	3 mt
Generator	12/24 V, DC

66.* The Wind Energy Supply Co. Ltd. (WESCO),
Iroko House,
Bolney Avenue, Peacehaven,
Sussex BN9 8HQ,
U.K.

Product :

Electricity generating windmill.

Wind Electric Generators

67. * Wind-Matric Aps
Vester Lindvej 32,
DK-7400 Herning,
Denmark.

Telephone : (07) 124032

Product :

Electricity generating windmills.

68. * Wind Power Systems, Inc.,
P.O. Box 17323, San Diego,
CA. 92117,
U.S.A.

Product :

Electricity generating windmills.

69. * WTG Energy Systems, Inc.,
251 Elm Street,
Buffalo, N.Y. 14203,
U.S.A.

Products :

Large wind turbine generator systems; tri-blade wind machines.

70. Windworks, Inc.,
Rt. 3, Box 44A,
Mukwonago, WI. 53149,
U.S.A.

Telephone : 414-363-4088

Activities :

Non-profit company. Wind energy work commenced in 1970. Designs wind-driven generator systems, including synchronous inverters and towers, and provides

design information on a consulting basis.

Publications :

Brochures, documentation and detailed drawings of 8 kw system.

Windmill Specifications : (Electricity generating, horizontal axis windmill)

Model	WINDWORKER 10
Rotor diameter	10 mt
No. of blades	3 (free flapping blades)
Blade material	aluminium
Cut-in-windspeed	3.5 mt/sec
Survival windspeed	75 mt/sec
Transmission	direct drive
Maximum power output	10 kw (permanent magnet inverter achieves full power output at 15 rpm. Output is converted to line voltage and frequency by Gemini Synchronous Inverter)
Tower (various heights)	18 mt, 24 mt or 30 mt
Tower material	steel
Generator	DC

71.* Winflo Power Ltd.,
Unit 15, 90, Esna Park,
Drive Markham, Ontario,
Canada L3R 2RL.

Product :

Electricity generating windmill.

72. Zephyr Wind Dynamo Co.,
P.O. Box 241,
Brunswick, Maine,
ME. 04011,
U.S.A.

Telephone : 207-725 6534

Wind Electric Generators

Contact : Richard Vaglia, Customer Services.

Products :

Small wind turbine generator systems; vertical axis wind machines;(VLS-PA) alternators for wind powered systems.

Publications :

Product information sheets (drawings, graphs, diagrams)

Windmill Specifications : (Electricity generating windmill)

Model	tetrahelix S, vertical axis, gyromill
Rotor diameter (mt)	0.6
Blade materials	dacron, nylon, aluminium, kevlar ties
Weight rotor (kg)	1.35
Weight system (kg)	2.25
Cut-in-windspeed (mt/sec)	5.3
Cut-off-windspeed (mt/sec)	none
Governing	non-destructive collapse in high winds
Max. power output at 11 mt/sec	7 W
Generator	14V DC permanent magnet

WATER PUMPING WINDMILLS

1. Aeromotor,
   Div. of Valley Industries,
   P.O. Box 1364, Conway,
   Arkansas 72032,
   U.S.A.

   Telephone : 501-329-9811

   Contact : William Barney.
   Patrick E. Sullivan, Manager of Administration.

Water Pumping Windmills

Products :

Farm windmills; towers; vertical axis wind machines; multi blade wind machines.

Publications :

Specification brochures (illustrated).

Windmill Specifications : (Water pumping windmills - multi blade fanwheel coupled to reciprocating cylinder pump)

MODEL

MODEL	702X	702A	702B	702D	702E	702F
Rotor diameter (mt)	1.8	2.4	3.0	3.7	4.3	4.9
No. of blades	18	18	18	18	18	18
Transmission	gears	gears	gears	gears	gears	gears
Strokes (inches)	$5\frac{1}{2}$, 3	8, 6	10, $7\frac{1}{2}$	12, 9	14, 10	16, 12
Shipping weight (kg)	95	161	293	494	769	1111
Cut-off-windspeed (mt/sec)	11	11	11	11	11	11

Governing	automatic turning out of wind
Pumps in various sizes	diameter 4-20 cm, piston type
Towers type: stub tower, four-post tower	stub tower, four-post tower

Tower height (mt)	6.4	8.2	10.1	12.2	14.3
Tower height (kg)	177-231	222-408	268-725	315-869	381-10

2. Aerowatt,
37, rue Chanzy,
75011 Paris,
France.

Telephone : 371-35-78
371-36-21

Telex: 680160 F SYSNA

Product :

Wind generators.

Water Pumping Windmills

Publications Received :

'Aerowatt Wind Generators Serial G' with illustrations and specifications. Brochure. Technical reports ('Aerowatt Water Pumping', 'Aerowatt 18 KFP 7 Wind Generator for Independent network').

Windmill Specifications :

Rotor diameter (mt)	1.2	2.0	3.2	3.2	3.2	5.0	9.2
No. of blades	2	2	2	2	2	2	2
Blade Material	Extruded Al alloy blades/stainless steel/protecte steel						
Weight rotor (kg)	30	97	196	176	220	350	976
Cut-in-windspeed (mt/sec)	2	2	2			2	2
Governing	Variable pitch						
Power output							
at 7 mt/sec	17	85	171			550	4000
at 5 m/sec				100			
at 10 m/s					1200		
Generators	12, 24, 36, 48, 120V DC; 220, 380V AC						

Applications :
1) Marine and air navigation aids.
2) Telecommunication relay stations.
3) Meteorological, oceanographic and seismic stations.
4) Rail signalling.
5) Cathodic protection of pipeline.
6) Pumping stations.

3. * Ateliers et Chantiers Navals de Chalon-sur-Saone,
B.P. 103,
71103 Chalon-sur-Saone,
France.

Product :

Water pumping windmills.

Water Pumping Windmills

4.* Bosman, B.V.,
P.O. Box 3701,
3265 ZG Piershil,
The Netherlands.

Telephone : 0031-18691022 Telex: 24475

Product :

Windmills for land dewatering and/or irrigation.

Publications :

'Bosman Fully Automatic Windmill' leaflet, graphical drawings and price list is available from the manufacturers.

5.* Bowjon,
2829 Burton Ave.,
Burbank, CA. 91504,
U.S.A.

Product :

Mechanical wind machines.

6.* Chalk Wind Systems,
P.O. Box 446,
St.Cloud, FL. 32769,
U.S.A.

Products :

Farm windmills; multi blade windmills; wind turbine generator systems.

7.* Climax Windmills (Pvt.) Ltd.,
General Hertzog Road,
Box 20244, 1934 Peacehaven,
South Africa.

Product :

Water pumping windmills.

Water Pumping Windmills

8. Dempster Industries, Inc.,
P.O. Box 848,
711 South 6th Street,
Beatrice, NB. 68310,
U.S.A.

Telephone : 402-223 4026

Publications :

Specification sheets.

Product :

Farm windmills (towers, pumps and cylinders).

Specifications : (Water pumping windmills - multiblade fanwheel coupled to reciprocating cylinder pump)

Model No.	12	12A	12	12	12
Rotor diameter	6 mt	8 mt	10 mt	12 mt	14 mt
No. of blades	15	15	24	18	18
Blade material		Galvanized	steel		
Weight rotor	45 kg	54 kg	67 kg	150 kg	277 kg
Weight system	126 kg	174 kg	225 kg	420 kg	650 kg
Cut-in-windspeed (mt/sec)	2.2	2.2	2.2	2.2	2.2
Cut-off-windspeed (mt/sec)	22	22	22	22	22

Governing — rotor turns out of the wind
Pump in various sizes : piston type 5-10 cm
Towers of various heights(ft) : 22, 28, 33, 30, 39, 40

9. Enertech,
P.O. Box 420,
Norwich, VT. 05055,
U.S.A.

Telephone : 802/649-1145

Water Pumping Windmills

Products :

Anemometers; farm windmills; small wind turbine generator systems; towers; wind direction indicators.

Publication :

Brochure describing the Enertech 1800

Windmill Specifications : Electricity Generating Windmill

Model	1500	1800
Rotor diameter	4 mt	4 mt
No. of blades	3	3
Blade materials	wood	wood
Weight (rotor)	21.6 kg	27 kg
Weight (system)	83 kg	120 kg
Cut-in-windspeed	4 mt/sec	4.5 mt/sec
Cut-off-windspeed	18 mt/sec	17.9 mt/sec
Governing	automatic brakes	automatic brakes
Max. output at 11 mt/sec	1650 W	2100 W
Generator	115 V AC induction	115V AC induction

10. Eoliennes Humblot,
8 rue d'Alger,
Coussey,
88300 Neufchateau,
France.
Telephone : Neufchateau (29) 94-09-09

Product :

Water pumping windmill; 'IOEOLEC' aerogenerators.

Publications :

Specification brochures (in French).

Water Pumpin· Windmills

Windmill Specifications : Water pumping windmills in 5 models : CADETEOL, SUPERCADETEOL, JUNIOREOL, GEANTEOL, and GOLIATEOL.

MODEL	CADETEOL	SUPERCADETEOL
No. of blades	6	8
Rotor diameter	1.75 m	1.75 m
Cut in speed	2.5 m/s	2.5 m/s
Cut off speed	10 m/s	10 m/s
Governing	automatic	automatic
Max. pumping depth	7 m	12 m
Max. output	500 litres/hr	600 litres/hr
Total weight	165 kg	165 kg

MODEL	JUNIOREOL	GEANTEOL
No. of blades	16	16
Rotor diameter (various sizes)	2m, 2.25m, 2.5m 2.75 m	3.5m, 4m, 5m
Head	'IDEE' or 'IDEALE' with fixed stroke 'IDEALO' or 'IDEESSE' with adjustable strokes	Head No. 1 or No. 2 with adjustable strokes
Max. output	2000 litres/hr	25,000 litres/hr
Max. pumping depth	40 m	170 m
Tower height (different sizes)	5.25m, 6.55m, 8.85m 12.3m	5.3m, 9.3m 13.3m
Total weight	400 kg to 800 kg	Approx. 2000 kg

(Other parts include rudder, outlet pipe, delivery device)

MODEL GALIATEOL, a heavy duty machine is being prepared and will be marketed after summer 1981. Its maximum planned output will be 100,000 litres/hr.

11.* Gebr Bakker,
Zevenpelsen 25,
8651 BT IJlst,
Holland.

Product :

Water pumping windmills

12.* Heller-Aller Co.,
960 Oakwood Ave.,
Napoleon, OH. 43545,
U.S.A.

Products :

Farm windmills; pumps; towers; wind machine; multi blade machines;

13.* B. Hertog,
Julianastraat 10-14,
2751 GD Moerkapelle,
Holland.

Product :

Land dewatering windmill.

14.* Naesbjerg Maskincenter,
Kirkediget 8,
Naesbjerg,
DK-6800 Varde,
Denmark.
Telephone : (05) 267111

Product :

Water pumping windmill.

15.* Sjorslev Maskinforretning,
Sjorslev,
DK-8620, Kjellerup,
Denmark.

Product :

Water pumps.

16.* Southern Cross,
Toowoomba Foundry,
P.O. Box 109,
Toowoomba,
Australia 4350.

Product :

Water pumping windmill.

17.* Stewart & Lloys,
P.O. Box 74,
1930 Vereeniging,
South Africa.

Product :

Water pumping windmill.

18.* Sydney Williams & Co. Pvt. Ltd.,
Constitution Rd Dulwich Hill,
Sydney N.S.W. 2203,
Australia.

Product :

Water pumping windmill.

19.* Ten-Fa Iron Works,
188 Kung Fu Road,
Chin-Li Chen,
Tainan Hsien,
Taiwan.

Product :

Water pumping windmills

Water Pumping Windmills

20.* Vetsak,
Postbus 3,
Isando TVL, 1600
Republic of South Africa.

Product :

Water pumping windmills.

21.* Wakes & Lamb Ltd.,
Millgate Works,
Newark-on-Trent,
Notts NG24 4XB,
U.K.

Product :

Water pumping windmills.

22.* Ernest Hayes (N.Z.) Ltd.,
Box 23-042,
789, Main South Road,
Christchurch,
New Zealand.

Product :

Water pumping windmills

23. Wind Machines Div.,
Auto Spare Industries,
C-7, Industrial Estate,
Pondicherry 605 009,
India.

Publications :

Brochure with specifications and graphs.

Water Pumping Windmills

Product :

Multiblade windmills for pumping water.

Windmill Specifications : (Horizontal axis, multi-bladed water pumping windmill)

Special Features :

Low cut-in velocity, back geared, automatic regulation, fully lubricated, adjustable strokes, low maintenance.

Blade material : galvanised steel
Cut-in-speed : 7/8 km.p.h.
Pumping power capacity at 25 km.p.h. windspeed is shown below :

	MODEL: DW - 200 G		MODEL: DW - 400 G	
evation etres	Cylinder Size Millimetres	Rated Pumping Capacity Litres/Hour	Cylinder Size Millimetres	Rated Capaci Litres/
4 m	100 mm	3000 lts/hr	175 mm	18000 lt
30 m	45 mm	650 lts/hr	80 mm.	3300 lts
90 m			45 mm	800 lts/

24. Wyatt Bros. (Whitchurch) Ltd.,
Wayland Works,
Whitchurch, Salop SY13 1RS,
England.

Telephone : 2526/7/8

Contact : W.W. Wyatt and R.D. Wyatt, Directors.

Products :

Water pumping windmills; wind pumps for shallow wells (suitable for total suction lift up to 25 feet); wind pumps for deep wells (more than 25 feet deep).

Water Pumping Windmills

Publications :

Publication No. 103 which shows the full range of Climax Windmills.

Windmill Specifications :

Currently 8 ft, 16 ft, and 18 ft mills are being made on towers 15 ft to 60 ft high. Climax windmills are multi bladed. Except for the smallest size, every mill has a variable stroke. Duplex machine cut gears are provided. There is an automatic governing device and the towers, sailwheel and tailvane are hot dip galvanized after manufacture as a general guide, a windmill of 12 ft size and under will commence pumping in a breeze of 6-7 mph and the larger windmills in one of 8-9 mph.

SUBSYSTEMS AND COMPONENTS

BLADES

1.* Okaer Vind Energi,
E. Grove Nielsen,
Baekkegardsvej 38,
DK-8800, Viborg,
Denmark.

Telephone : (06) 645349

Product :

Blades for windmills.

Subsystems and Components

Blades

2.* Propeller Engg. Duplicating,
403, Avevida Teresa,
San Clemente, CA. 92672,
U.S.A.

Product :

Wind turbine blades.

3.* Structural Composites Industrial, Inc.,
6344 North Irwindale Ave.,
Azusa, CA. 91702,
U.S.A.

Product :

Wind turbine blades.

4.* Volund A/s,
Fiberglass Technology Div.,
Marsk Stigs Vej 4,
DK-8800 Viborg,
Denmark.

Product :

Blades.

TOWERS

1.* American Tower Co.,
Shelby, OH. 44875,
U.S.A.

Product :

Towers.

Subsystems and Components

Towers

2.* Astro Research Corp.,
P.O. Box 4128,
Santa Barbara, CA. 93103,
U.S.A.

Product :

Towers.

3. Solargy Corp.,
17[illegible]4 East Warren Ave.,
Detroit, Michigan 48224,
U.S.A.

Telephone : 313-881 5510

Contact : Bror Hanson, President.

Activities :

Wind energy work commenced in 1977.
Active as distributor and manufacturer.

Products Distributed :

Small wind turbines - Enertech 1500.
Large wind turbines - ALVAWT - Aluminum Company of America - (60 kw to 500 kw)

Products Manufactured :

Solargy towers.
1) Monotube (free standing/steel) 40'-90'
2) Lattice (free standing/steel) 40'-120'
3) Lattice (guyed/steel) 40'-120'

Publications :

Product information sheets.

Subsystems and Components

Towers

4.* Unarco Industries, Inc.,
Unarco-Rohn Div.,
6718, West Plank Road,
Peoria, IL. 61604,
U.S.A.

Product :
Towers.

/RHM

LATE ADDITIONS

DENMARK

1. DEFU,
The Research Association of the
Danish Electric Utilities,
Lundtoftevej 100,
2800 Lyngby,
Denmark.

Telephone: (02) 88 14 00   Telex: 3 75 29 DTHDIA DK

Contact : Mogens Johansson, Electric Engineer.

Activities :

Work began in 1974.
Activities include coordination of following projects:
1) Construction and testing of two large-scale wind turbines at Nibe.
2) Carrying out of a measuring program for investigation of the major properties of the Gedser windmill (200 kw).
3) Other investigations include site locations for a large number of wind energy conversion systems about 1000-2000 of them.

Budget :

10m DKr. 2m U.S. $

Funding Source :

Government and electric utilities.

Publications :

Programme summaries/project evaluation reports, technical reports.

Personnel ·

Mr. Paul Nielsen, Electric Engineer, DEFU.

Late Additions

SWITZERLAND

1. World Council of Churches,
Commission on the Churches,
Participation in Development,
150, route de Ferney,
1211, Geneva 20,
Switzerland.

Telephone : 33 34 00 Cable: 'OIKOUMENE'

Activities :

Built and maintained the Sahores windmill which was used for pumping water. At present any activity with the windmill is stopped.

Publications :

Plan and building process of the Sahores windmill are available in French.

U.K.

1. Loughborough University of Technology,
Dept. of Mechanical Engineering,
Leicestershire, LE11 3LY,
U.K.

Telephone: L'BORO 63171 Telegram: 'TECHNOLOGY LOUGHBOROUGH'
Telex: 36319

Contact : Dr. A.J. Alexander.

Activities :

1) Present R&D includes study of means of improving performance of Savonius Rotors wind tunnel interference.
2) In future, R&D will include study of air flow through windmill clusters using laser Doppler anemometers. Continuation of work on wind tunnel interference in windmill testing.